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POWER

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POWER GENERATION
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DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
ELECTRICITY & ELEVATORS
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POWER MISCELLANY

JANUARY, 1937

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Glimpses into the World's Largest Turbine Workshop

STEAM STREAM

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GENERAL

P O W E R

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PHILIP W. SWAIN

Editor

Blind Budgets

BUDGETEERS have their troubles, like everybody else, so perhaps we shouldn't be too hard on them. Yet strange things happen and must be noted. For example, we recently heard of a case where a power-budgeting "economy" of $600 reduced net earnings by $8,400.

It was a large corporation with many highly engineered plants and an elaborate centralized cost system. Figuring that every department head will waste money if not held in check, the budgeting brass hats had a habit of trimming items all the way down the list. Total savings, according to their logic, were the sum of the individual cuts.

Things looked pretty black in 1932, so they chipped $200 off of the 1933 maintenance budget for power equipment in one of the plants. Anxious to oblige, the power engineer cut his suit to fit the cloth. He saved them $200 on maintenance in 1933, another $200 in 1934 and still another in 1935. Everybody was happy—that is, everybody except the engineer, who knew that company dollars saved at the maintenance spigot were pouring out of the fuel-bill bunghole.

Here's what he was up against: His plant contained a large high-pressure feedwater heater operating 24 hr. a day, 365 days a year. This heater could deliver 310-deg. feedwater if clean, but scaling had cut the feed temperature to 270 deg. F. when the spring of 1934 rolled around.

Cleaning would cost $200 altogether. The money wasn't there, so the heater had to limp along with its load of scale. This state of affairs continued until the spring of 1936. By that time the waste became intolerable to the engineer, so he cleaned the heater, budget or no budget.

Company cost experts figured this history as a clear saving of $600 for the three omitted cleanings. As a matter of fact, the coal wasted by not cleaning yearly totalled $9,000 for the 3-year period, leaving a net loss of $8,400.

"Wasn't the engineer budgeted on coal also, and didn't he strike a snag there with his accounting system?" He was so budgeted, but he didn't strike the snag, because his budget allowed the usual quantity of coal per unit of product. Improving business increased factory output and thereby raised boiler-room efficiency enough to offset the feed-heating waste. Everything looked rosy on paper, but Shakespeare was right, "all that glitters is not gold."

Things like this happen every day in large organizations willing to pay the price of first-class engineering and budgeting brains. Evidently the two don't always get together before decisions are made. Sometimes it's the engineer's fault, but often it is not. Some managements don't encourage objections to the arbitrary chiseling of budgets.

This business of playing czar is all right if the czar knows just what's best for the company. The trouble is he never does. In business, as in government, no one brain is big enough to decide everything wisely. The real problem of business—particularly of highly organized big business—is to use the brains it hires.

DIESEL-POWERED COMMUNITY

Since 1921, Freeport, N. Y., has built up a 7,900-kw. diesel plant. Here are operating data, methods and costs on the newest unit

By J. W. Anderson
Consulting Engineer

FREEPORT, Long Island commuter community of 20,000, has had its own power plant since 1897. The original steam plant grew to an eventual installed capacity of 600 kw. before it was augmented in 1921 by the station's first diesel, a 365-hp. (250-kw.), 4-cycle, 4-cyl. unit. Load growth has necessitated frequent prime-mover additions since then.

In 1928 the steam plant was removed, by which time diesel capacity had reached 2,750 kw. A year ago, the original diesel was removed to make room for the newest 2,250-kw. unit, completed early in 1936. The present plant includes seven engines, totalling 11,850 hp. or 7,900 kw. They include: two 4-cyl., 750-hp. (450-kw.); two 6-cyl., 1,125-hp. (750-kw.); one 8-cyl., 1,500-hp. (1,000-kw.); two 10-cyl., 3,300-hp. (2,250-kw.). All are Busch-Sulzer 2-cycle engines, the first five air-injection crosshead type with direct-driven 3-stage air compressors, the last two trunk-piston solid-injection units with separate motor-driven scavenging-air blowers. All generators are General Electric except the latest one, which is a Westinghouse unit.

There is very little industrial load on the station; rather it serves residential and municipal needs. There are about 5,475 customers. Here is the division of load for a recent month:

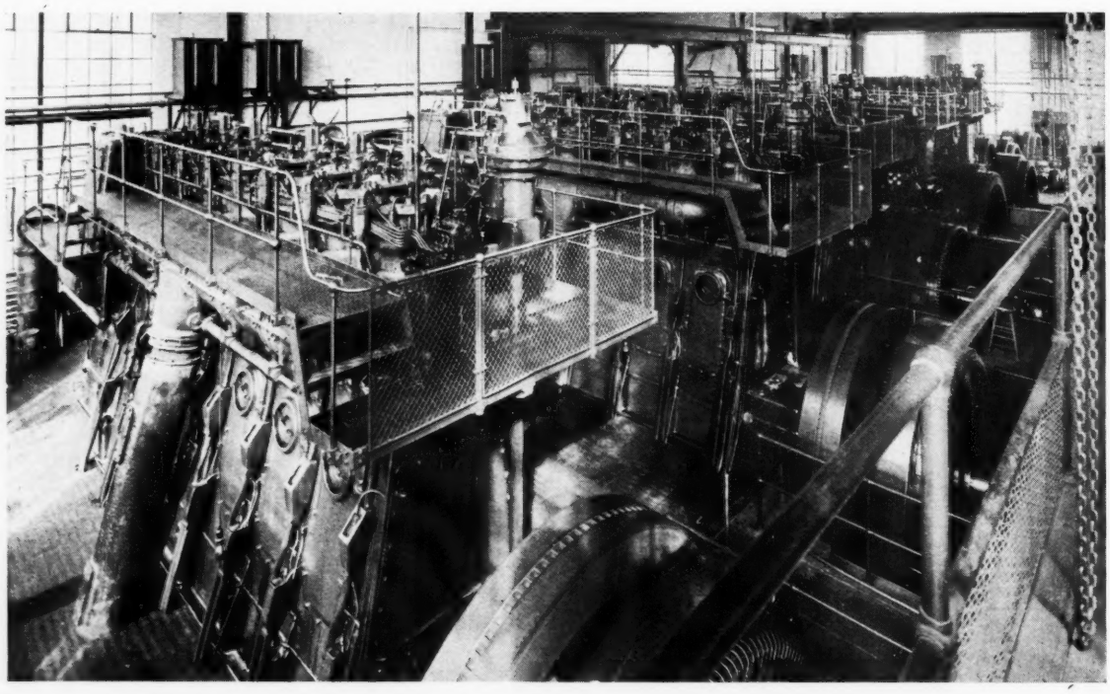
Customers	664,821	kw. hr.
Municipal	33,414	"
Street lights	90,998	"
Water department	69,013	"
Power plant	117,927	"
Line losses and unaccounted for (9.2%)	100,077	"
Total energy generated	1,076,250	"

The item marked "power plant" includes energy required for the motor-driven scavenging-air blowers for the two large units. In fact, it is about two-thirds of that item. Each blower requires 207 kw. at the switchboard while running, regardless of what load is being carried on the engine. That figure includes of course the electrical losses in the generator and motor. Total generation of energy for the plant for the past year from Nov. 1, 1935, to Nov. 1, 1936, was 11,808,390 kw.-hr. A typical daily load curve for a November day is shown. There is obviously a large reserve capacity of engine-generator power, and advantage is taken of the size and number of units by operating them with running units loaded to between 80 and 90% of rated capacity.

Fuel Oil

Fuel oil used is No. 3, U. S. Navy standard, except that gravity is limited to 28-34 and the fuel must be distillate. Residue fuels are forbidden. Delivery is by tank car set off on a railroad siding which runs past the plant. Before a car is unloaded, a sample is tested for gravity at proper temperature. If satisfactory, the oil is run into four above-ground storage tanks. Two are 20,000-gal. apiece and two 25,000 gal. each.

The practice is to use fuel out of the tank which has been settling the longest. Each engine has its own day tank on the wall near the engine end. Tanks have an approximate capacity for only 2 hr. running, so that the operators must give attention to the fuel situation regularly and frequently. Three pumping units take fuel from storage tanks to day tanks. Control switches are distributed along the length of the engine room and the operator can fill any day tank with any of the three units. Valves for controlling delivery to each tank are located at each unit. In addition, there is an emergency pumping unit which is tested once a week. There is no preparation for this test; the manager walks onto the



Freeport station, showing the newest and the earliest units at the far end

floor and asks to have the emergency unit used for filling one day tank.

Each engine's fuel supply is measured by a Worthington piston-type meter on the line to each day tank. Also, in each line is a twin Sarco strainer. Air-injection engine fuel flows by gravity from the day tanks through a duplex filter with gauze and felt filtering elements, then to the engine fuel-measuring pumps. On the solid-injection engines, there is a booster pump which forces the fuel through Cuno filters on its way from the day tank and gauze and felt strainers to the injection pumps.

Lubricating oil is Gargoyle DTE extra-heavy. Grade AA is used in the mechanical lubricators for the cylinders of solid-injection engines, Galena extra-heavy on bearings and BB for cylinders on air-injection engines. Each engine has its own rest tank alongside its foundation. An engine-driven pump takes its suction from the rest tank through a strainer and delivers to the engine header which supplies the bearings and piston-cooling systems in the two largest units.

Lubricating oil is cleaned on the batch system every 400 to 500 hr. of engine operation by running it through the station DeLaval centrifugal purifier, after heating by steam to about 180 deg. F. The latest unit has its own DeLaval centrifugal purifier with a thermostatically controlled electric heater, which runs all of the time the engine is in operation. Oil is taken from one end of the rest tank and returned to it at the other end. This arrangement is being tried to get a comparison with the other method. Experience to date is that this system keeps the oil at a better color, but of course more equipment is required and thus expense is a little higher.

Cooling System

Engine cooling water is circulated through a cooling tower back of the station and placed high enough to give gravity flow through the engine jackets. This cooling tower is a little shy in capacity under full-load conditions in the summer, and consideration is being given to an increase. Since the air-injection engines have water-cooled pistons, booster pumps taking their suction from the supply main from the basin under the tower, deliver to the piston circuits. All water overflows to the hot well, from whence it is pumped back to the tower top for cooling. Low-pressure alarms are installed on piston-cooling and jacket-water headers. There are also high and low water-level lights for the cooling-tower basin.

Makeup feed amounting to about 2,500 g.p.d. is taken from the village reserve mains obtained from local deep wells. It is slightly acid, and to counteract this and to avoid corrosion, enough Du-Both compound is added to keep the water at a pH of 8.2. A LaMott comparator tests the water. In the cooling-water system between pumps and cooling tower, there is a 6-in. twin Blackburn-Smith strainer for removing oil and suspended solids. However, under full-load conditions this strainer is not large enough to handle all water being circulated, and so some is bypassed. This is of course unsatisfactory and consideration is being given to fitting more strainer capacity.

The air-injection engines compress their own starting air, and there is a motor-driven 2-stage

John T. Cotter, plant manager, standing before the new unit

compressor for the solid-injection engines. Starting bottles for all the engines are cross-connected.

The station building is heated by steam from a heating boiler fired by fuel oil. The cost of this heating runs about $2,100 a year, and the use of exhaust-gas waste-heat boilers is being investigated. Warm water for the wash room is already being obtained from coils in the engine exhaust pipes.

As the load curve indicates, the peak is in the evening, and shifts for the operators are arranged accordingly. On the 6 a.m. to 2 p.m. shift there are two men on watch. From 2 p.m. to 10 p.m. there are three men. And from 10 p.m. to 6 a.m. there are two men again. There is also an extra man on duty from 6 p.m. to 2 a.m. Thus he overlaps two regular watches, and there are four men on duty during the heavy-load period. In addition, there are two relief operators.

Maintenance

All maintenance work is done by special maintenance crews. A group of five, consisting of the man in charge with four assistants, is responsible for all engine work. There is one electrician and helper who handle all electrical work. Then there is another group of five, a foreman with four assistants, which handles all other maintenance. In the manager's office is an assistant who is a qualified engineer, and who fills jobs of the regular crew members absent on account of sickness or vacations.

Every man has one day off every week, every holiday or the equivalent, 2-weeks vacation, and sick leave, all with pay. They work a maximum of 291 days per year. In addition, they are protected by workmen's compensation, and the New York State Employees Retirement System.

It is obvious that considerable attention is given to maintenance. Back of the engine room is a good-

The operating crew at Freeport

sized machine shop and storeroom. Some $15,000 worth of spare parts are carried on hand at all times. These are well taken care of and stored neatly and conveniently in metal storage bins. The machine shop is equipped to do all repair work, and this has helped materially in reducing maintenance costs. The geographical location of the plant does not provide any shops nearby which could be depended upon for such work, so that it was considered advisable to provide complete facilities in connection with the plant. In fact, some repair work is done for other departments of the village.

While there is a regular maintenance schedule, special attention is given to the observations and reports of the operators who note, in a book provided, every defect or irregularity. It is the duty of the maintenance crew to clear that book daily.

The shop is equipped with these tools: tool grinder, small lathe, precision drill, small shaper, key seater, large shaper, piston-ring grinder, radial drill, boring mill, large lathe, milling machine, electric welder, gas welder, babbitting furnace, blacksmith's forge, dolly crane, and a complete assortment of small tools. The shop and all tools are served by a 2-ton traveling crane. Of course there are special slings and equipment for engine parts which are handled frequently in maintenance. Then there is a washing and charging outfit for air-filter elements.

Pumps for the village water and sewer services are float-controlled; thus load from them may come on at any time. But it may be possible for an unexpected load combination to raise engine loading above the point where it can be handled comfortably. To preclude this, there is remote control at the power station for parts of the municipal load, such as the water pumps. Then, if necessary, station load can be eased temporarily by dropping part of it until another engine can be started. There is sufficient standpipe reservoir capacity to meet all requirements far beyond the time needed.

Recent average yearly cost figures are as follows, in mills per net kw.-hr.:

Fuel oil at 4.71c per gal.	4.43
Lubricating oil—at 58.9c. per gal.	0.50
Attendance cost	2.20
Supplies and water	0.96
Engine repairs	1.14
All other repairs	0.46
Total production cost	9.69

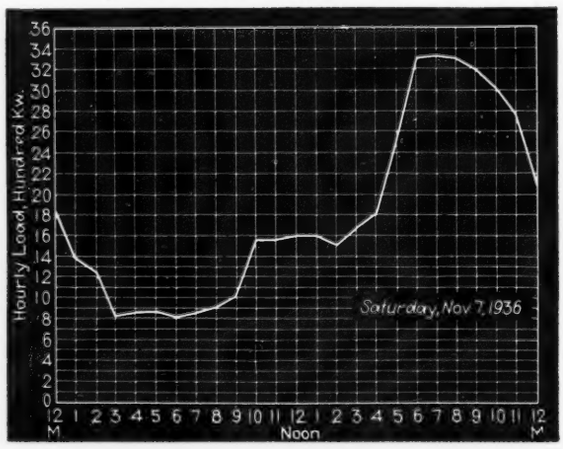
These figures were obtained with an annual plant load factor of 35.3%, a running plant capacity factor of 66.2% and an annual plant service factor of 32.8%. These represent results of a steady reduction in energy costs over a period of years, due partly to economies effected in station operation and partly to increase in energy production. Costs of supplies and repairs have been materially reduced. But this is not the end by any means.

Latest station figures for fuel-oil consumption show a gross kw.-hr. production per gal. of 11.93 against 11.76 corresponding to the cost figures in the tabulation. The current station lubricating-oil figure is 1,375 gross kw.-hr. per gal.

Now compare these with the showing made by the solid-injection engines during recent months:

	UNIT 7	UNIT 8
Average load, kw	1437	1452
Gross kw.-hr. per gal. of fuel	14.11	13.67
Net kw.-hr. per gal. of fuel, deducting for motor-driven scavenging blower	12.10	11.72
Gross kw.-hr. per gal. of cyl. lub. oil	1754	1899
Engine hr. per gal. of cyl. oil	1.22	1.30
Cost of cyl. lube oil per 1,000 kw.-hr., ¢	34	31
Gross kw.-hr. per gal. of bearing oil (The figure for No. 8 is high because it is a new engine)	8711	2898
Engine hr. per gal. of bearing oil	6.05	1.99
Cost of bearing oil per 1,000 kw.-hr., ¢	5.89	1.77
Total cost of lube per 1,000 kw.-hr., ¢	39.89	48.7

A typical daily load curve



COST OF NO. 8 UNIT INSTALLATION

Engine, net contract price	$111,002.01
Blower Motor, temp. detector coils	98.00
Purchase Orders	10,847.86
Stores Requisitions, Power Plant	1,517.11
Stores Requisitions, Store House	172.55
Stores Requisitions, Highway Department	.48
Petty Cash	31.68
Foundation, Mr. Breed	905.00
Foundation, Good Roads	11,794.63
Labor, no managerial	8,801.69
Freight, Express and Carting	86.62
Interdepartmental, Street Department	11.50
	145,269.13
Credits	81.51
Total	$145,187.62
Generator and Exciter, Contract Price	$16,299.00
Purchase Orders	78.92
Stores Requisitions, Power Plant	31.46
Stores Requisitions, Store House	112.81
Petty Cash	6.89
Labor	1,289.90
Express and Carting	5.76
Interdepartmental, Line Department	33.08
Total	$17,857.82
Purchase Orders	$2,655.77
Stores Requisitions, Power Plant	67.60
Stores Requisitions, Store House	18.69
Labor	476.14
Petty Cash	.40
Total	$3,218.60
15-Ton Crane, Purchase	$999.25
Total Cost	$167,263.29

In other words, as station load increases and more of the total energy production comes from the large solid-injection units, costs will be reduced.

Fixed charges are also important. Since the first diesel unit was installed in 1921, station load demand has increased over 600%. Every addition to the station has been paid for out of earnings, except for a serial bond issue which will not be entirely paid off until 1947. Provisions written into the bonds prevent calling them before they are due. The total outstanding today amounts to $125,000, but there is more than enough cash on hand to pay them off if it were possible. All of this has been accomplished in the face of many reductions in electric rates.

Since 1931 there have been five reductions, so that today the average residential consumer pays 51.4% less than in 1931, 44.2% less than in 1932, 36.2% less than in 1933, 32.9% less than in 1934, and 23.3% less than in 1935.

Rates effective Dec. 1, 1936, are:

RESIDENTIAL

0 to 12 kw.-hr	$1.00	(minimum bill)
Next 28 kw.-hr	.05	per kw.-hr.
Next 160 kw.-hr	.035	per kw.-hr.
All over 200 kw.-hr	.02	per kw.-hr.

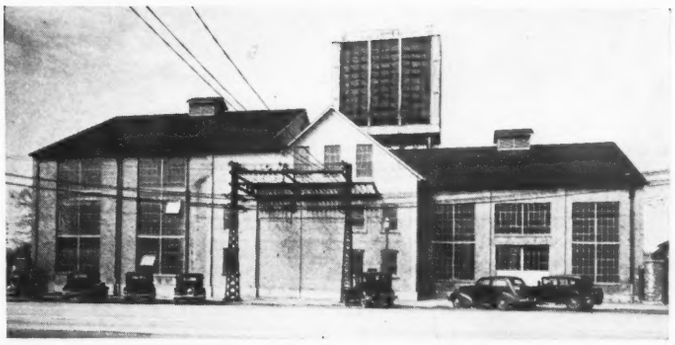
COMMERCIAL

0 to 12 kw.-hr	$1.00	(minimum bill)
Next 88 kw.-hr	.06	per kw.-hr.
Next 150 kw.-hr	.05	per kw.-hr.
Next 200 kw.-hr	.04	per kw.-hr.
All over 450 kw.-hr	.025	per kw.-hr.

Minimum charge of $1.00 per meter per month, plus $1.00 per kw. or major fraction thereof of demand over 1 kw. Discount: if paid within ten days of date rendered, 10% on all monthly bills up to $10 and 3% on that portion of the bill over $10.

The minimum bill has not been reduced for the reason that there are certain fixed costs that apply to every meter every month whether or not any power is consumed. These fixed charges have been determined to average $1.37 per meter per month.

In order to confirm the book valuation of the power plant for rate-making purposes and for presenting proper accounting figures to the Public Utilities Commission, Barker & Wheeler, New York, N. Y., were commissioned to make a detailed inventory study and report. This has just been completed and confirms the justification for the new rate structure now being adopted.



The cooling tower stands on a steel tower behind the plant

Looking backward and comparing his experience, John T. Cotter, the manager, favors the solid-injection engines. He regards the trunk-piston entirely satisfactory as compared with the crosshead construction in the older air-injection engines, and points out that in these particular trunk-piston engines connecting-rod length ratio is 5½ to 1, and that the piston has a very long skirt well guided by the lower liner ring below the inspection and oil-drainage port. This gives the piston unusual support.

Mr. Cotter has been in charge since 1927. He was trained under and has followed the policies established by the late Wm. R. Smith, who was in charge from the time the station was established until his death in 1927. Mr. Cotter reports to the Power House Committee, LeRoy C. Mountcastle, chairman, and this committee is appointed by the mayor, Robert E. Patterson. As far as the Village of Freeport is concerned, the municipal power plant has been and still is an unqualified success.

Looking Backward

Dr. C. E. Lucke sent us these choice abstracts from a revised edition of "The Literary and Scientific Class Book", originally published in 1821 by the Rev. John Platts of Doncaster, England. They illustrate the knowledge of heat and steam 115 years ago.—Editor

OXYDS AND COMBUSTION

Combustion may be defined to be a process by which certain substances decompose oxygen gas, absorb its base and suffer its caloric to escape in the state of sensible heat. The agency of oxygen in combustion is attributable to its affinity for combustible bodies. The combustible having a greater affinity to oxygen than oxygen has to caloric, the oygen gas is decomposed, and its oxygen combines with the ignited body, while its caloric, becoming free, is diffused among the surrounding bodies. Whenever we burn a combustible body, a continued stream of atmospheric air flows toward the fire place, to occupy the vacancy left by the air that has undergone decomposition, and which, in its turn, becomes decomposed also. Hence a supply of caloric is furnished without intermission, till the whole of the combustible is saturated with oxygen.

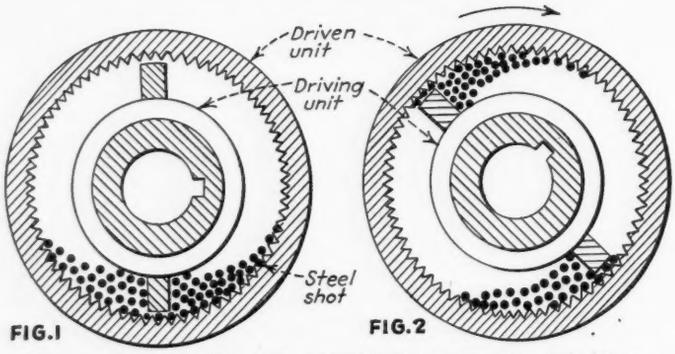
CALORIC

Heat is a well known sensation which we perceive on touching any substance whose temperature is superior to that of the human body. Chemists have agreed to call that matter of heat *caloric*, in order to distinguish it from the sensation which this matter produces.

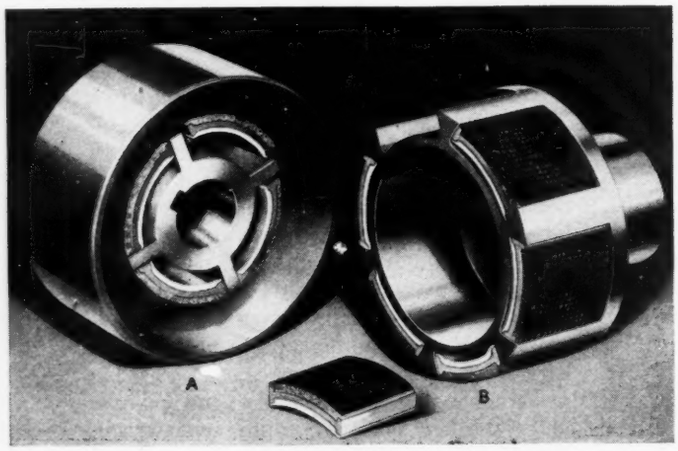
Caloric is uniform in its nature; but there exist in all bodies two portions, very distinct from each other. The one is called SENSIBLE HEAT, or free caloric; the other LATENT HEAT or combined caloric. Sensible caloric is the matter of heat disengaged from other bodies, or, if united, not chemically united with them. LATENT caloric is that portion of the matter of heat which makes no SENSIBLE addition to the temperature of the bodies in which it exists. Wrought iron, though quite cold, contains a large portion of LATENT CALORIC; and if it be briskly hammered for some time on an anvil, it will become red hot by the action of this species of caloric, which by the percussion of hammering is now evolved and forced out as SENSIBLE heat.

THE DIVING BELL AND STEAM ENGINE

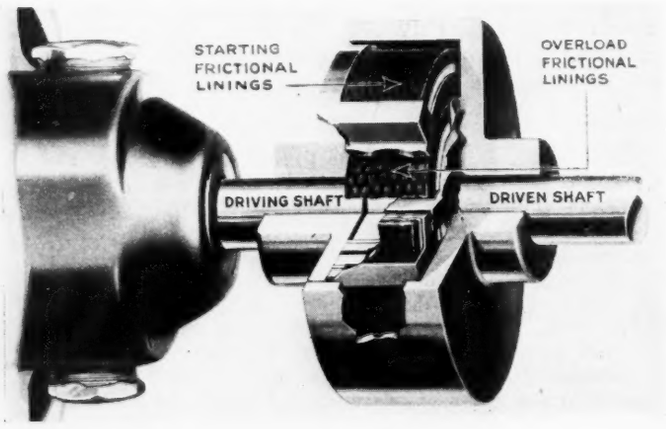
By the admirable contrivances of Watt and Fulton, the steam engine has become a thing stupendous alike for its force and flexibility—for the prodigious power which it can exert, and the ease, and precision, and ductility with which it can be varied, distributed and applied. The trunk of an elephant, that can pick up a pin or rend an oak, is nothing to it. It can engrave a seal, and crush masses of obdurate metal before it—draw out, without breaking, a thread as fine as gossamer, and lift up a ship of war like a bauble in the air. It can embroider muslin and forge anchors—cut steel into ribands, and impel loaded vessels against the fury of the winds and waves. It has armed the feeble hand of man, in short, with a power to which no limits can be assigned; completed the dominion of mind over the most refractory qualities of matter; and laid a sure foundation for all those future miracles of mechanic power which are to aid and reward the labour of after generations.



Figs. 1 and 2—Principle of an automatic clutch that uses steel shot as the clutching medium



Figs. 3 and 4—Parts and assembly of an automatic clutch using a friction band in the driving and driven elements



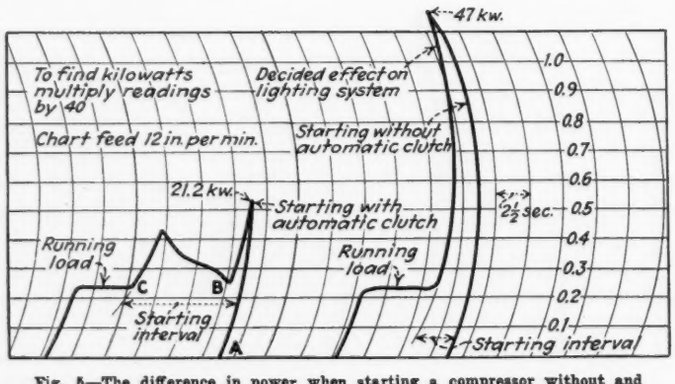


Fig. 5—The difference in power when starting a compressor without and with the clutch coupling, by a 15-hp., 1,750-r.p.m. squirrel-cage motor

DIFFICULT MADE

Automatic clutches accelerate loads that are difficult to start, without shock to driven machine or power system

WHEN power units are applied to a load, three conditions must be considered, starting, running and stopping. For many applications, all three are normal, therefore offer no unusual problems. For example, a centrifugal pump requires a low break-away torque, has low inertia, is comparatively easily accelerated, operates at practically constant load, and when power is disconnected it gradually slows down and stops. For such applications a normal-torque, across-the-line start, squirrel-cage motor and simple starting switch are ideal. There are many applications, such as on high inertia and high friction load where such simple power equipment cannot be used, unless in combination with a special mechanical-power transmission device.

To permit the use of simple motors and control equipment on such jobs, several types of automatic clutches have been developed, all in some way depending upon centrifugal force for their operation. The type of Fig. 1 is quite different from most designs. In it, the member keyed to the motor shaft is essentially a 2-bladed paddle wheel. A drum in which the paddle wheel is contained, is keyed to the driven shaft. In this drum is a quantity of steel shot about 0.02 in. in diameter, that forms the power-transmitting medium.

When the motor starts, the shot is at first either thrown ahead of the paddles or slips by them. As speed increases, centrifugal force throws the shot out against the drum with increasing force, thus increasing the resistance between the driving and driven members, and the load accelerates. When the load comes up to speed, the shot is distributed somewhat as in Fig. 2. Axial serrations on the inner surface of the drum help the shot resist the driving force of the paddles.

The automatic clutch coupling of Figs. 3 and 4 consists of two drum-shaped members, one attached to the driving shaft, the other to the driven shaft. Between driving and driven members are two sets of floating segments or shoes, usually of bronze reinforced with lead and faced with a brake lining. Shoe weight is varied to give the required pressure at rated speed to carry the load.

In Fig. 3, the friction shoes on driving member *B* fit inside the outer drum of driven member *A*. Friction shoes on the driven member go inside the drum

STARTING EASY

of the driving member, as in Fig. 4. Thus outer shoes are actuated by the driving member, inner shoes by the driven member. The two produce a combined action to accelerate the load smoothly and to give overload protection.

Starting a load with this coupling is done in three operations. First, the motor is allowed to start without load, hence it accelerates quickly. As it picks up speed, the outer friction shoes begin to exert a torque on the driven member. When the driven member begins to pick up speed, its shoes come into action on the inner drum to help accelerate the load.

Starting time for the load will vary considerably, depending on whether it is practically all inertia, partly inertia and partly friction, or practically all friction. Normally, the outer shoes are figured to transmit torque corresponding to rated motor horsepower and speed and the inner shoes made to transmit 40% rated motor torque. This combination covers most conditions of starting, but by modifing the number, size and weight of the shoes, practically any starting and running loads may be provided for.

Fig. 5 shows the difference between starting the same load without and with the clutch coupling, by a 15-hp. 1,750-r.p.m., 220-volt, squirrel-cage motor. When the motor is connected directly to the load, the power inrush is 47 kw., while with the clutch coupling it is less than half this value and exists for less than half the time. The power peak when starting without the clutch coupling may cause a serious flicker in the lights on the system, while with the automatic clutch the peak is so small and of such short duration that it is not noticeable.

In Fig. 5, from *A* to *B* the motor is starting without load and accelerates quickly. At *B* the starting shoes begin to take hold and as the machine speeds up it actuates the inner or driven shoes, which adds further starting capacity to bring the load to full speed at *C*. The load comes to full speed in about 8 sec. Power inrush for most of the time is less than 150% of motor rating.

On certain applications, such as on dual drives, the clutch shoes must remain released until after a predetermined speed has been reached. For these conditions the inner shoes of the clutch are omitted and outer shoes are held in the released position by flat springs, Fig. 6. The springs are held in slots cut in the walls separating the shoes, as in the figure. Stiffness of the springs is made such that the shoes cannot engage until a minimum actuating speed is reached.

On an internal-combustion engine, this coupling

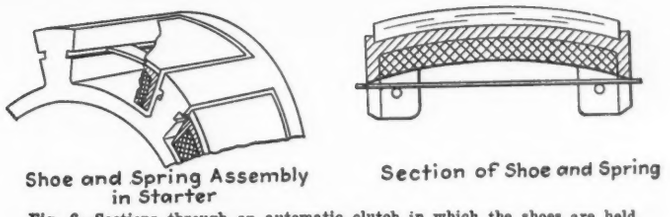


Fig. 6—Sections through an automatic clutch in which the shoes are held released until a predetermined speed is reached

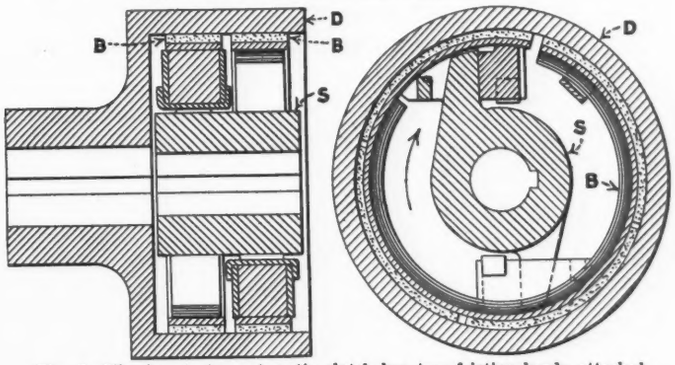


Fig. 7—Slip-ring-starter automatic clutch has two friction bands attached at one end to the driving hub

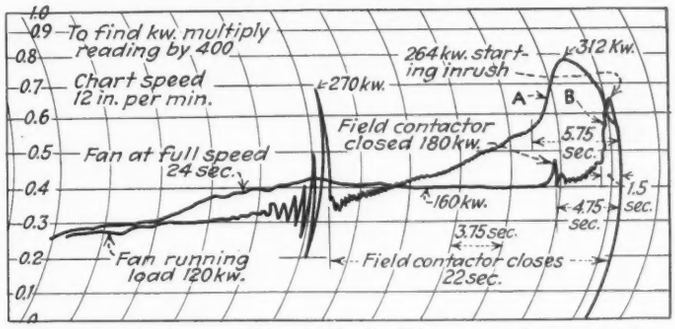


Fig. 8—Graphs from a 125-hp. 2,200-volt, 600-r.p.m. synchronous motor driving a mine fan before and after installing an automatic clutch

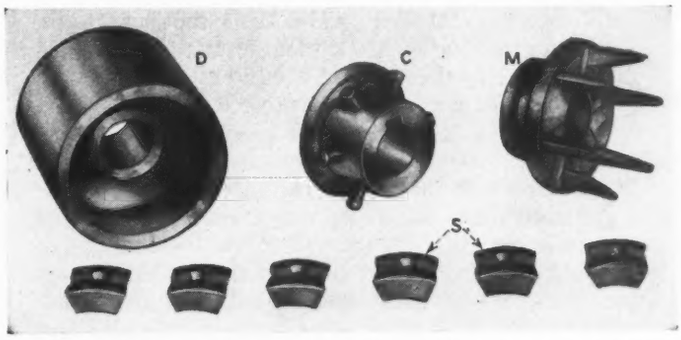


Fig. 9—Parts of an automatic clutch using cast-iron shoes on a carrier keyed to the driving shaft

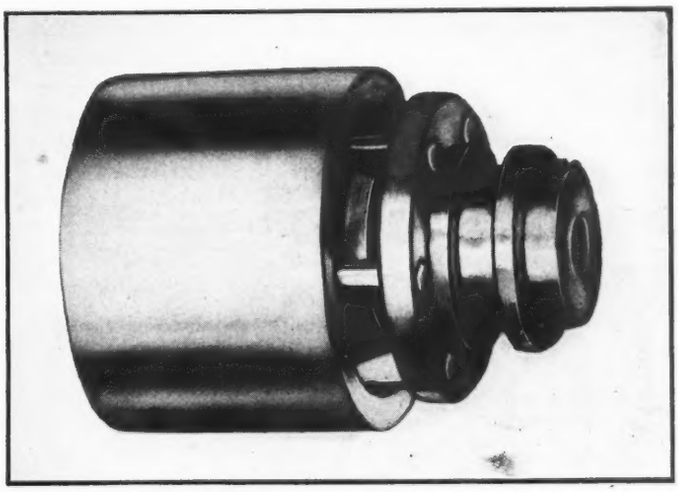


Fig. 10—Assembly of the automatic clutch, Fig. 9, which is applied automatically and can be released manually when running full speed

permits the engine to idle below the speed at which the clutch will function. This is a desirable feature during the period of warming up or where it is desirable to operate a machine intermittently. In the latter case, the coupling allows the engine to idle without operating the driven machine, automatically picks up the load whenever the engine speeds up, and again releases at idling speed.

Slip-ring Starter

Another clutch coupling, known as a slip-ring starter, is shown in Fig. 7. There are three elements in this starter, the spider *S*, two friction bands *B* and the drum *D*. The spider is keyed to the motor shaft and the drum to the shaft of the driven machine. One end of each band is connected to an arm on the spider, by which it is pulled, the rear or trailing end of the band being free. As the motor speeds up, centrifugal force causes the bands to expand and exert a frictional drag on the drum. Torque transmitted depends upon motor speed, diameter of drum and weight of bands. These starters are usually made for one direction of rotation, but can be built reversible if desired. They are, like the units Figs. 3 and 9, made in the coupling type and in designs with sprockets, pulleys, V-grooved sheaves for chains, flat-belt and multiple V-belt drives.

The slip-ring starter is inherently a limit-torque coupling. When applied to the high-inertia loads with a motor just strong enough to handle the running load, maximum load may be kept down to 120% of the motor rating. When applied to conveyors where sudden running overloads or stalling of the motor may occur, the starter is built to transmit a maximum of 150 to 200% of motor rated torque. In event the conveyor stalls, the starter slips, allowing the motor to continue to run until tripped off the line by the overload device. In this way both the conveyor and motor are protected.

The graphs of Fig. 8 were taken from a 125-hp. 2,200-volt, 600-r.p.m. synchronous motor driving a large mine fan through a gear speed reducer before and after installing a slip-ring starter. Before the starter was installed, the motor had been rebuilt to give it sufficient torque to bring the fan up to synchronous speed. But this change did not insure that the motor would do this at all times, so a slip-ring starter was installed. Without the starter, graph *A*, the starting peak reached 312 kw. and it required 22 sec. for the motor to reach a speed at which the field contactor closed, when a peak of 270 kw. occurred. Graph *B* was taken after the slip-ring starter was installed. Then, the maximum starting peak reached only 264 kw. and was of very short duration. The field contactor closed in 4.75 sec. after the main switch was closed, causing only a slight rise in power input, shortly after which the motor pulled into step. Power input then remains practically constant at 160 kw. until the fan had been brought up to speed. Thus, it is not only easy for the motor to start and synchronize, but the fan is brought up to speed without shock to the equipment or objectionable disturbance in the power system.

Another type of automatic clutch, Fig. 9, comprises a drum *D* keyed to the driven shaft and a number of iron shoes *S* freely carried on pins in a hub or carrier *C*, keyed to the driving shaft. The shoes, actuated by centrifugal force as the driving unit comes up to speed, press against the inside of the drum and gradually accelerate the load. Both starting and driving power can be varied in a given clutch by changing the weight and the number of shoes. Clutches with 2, 3, 4, and 6 shoes are being used.

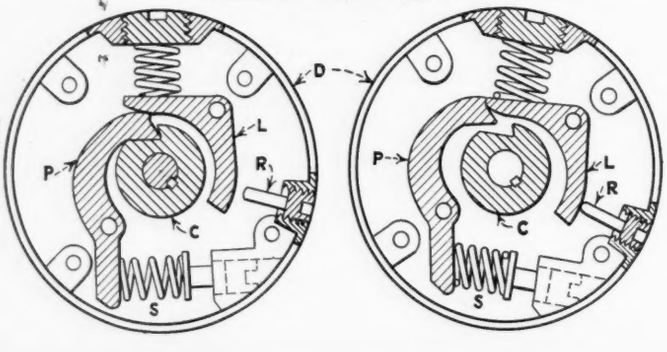
Manual control of the clutch can be had by adding the shift collar *M*. Prongs on this collar are so arranged that they will go inside the drum with running clearance but will force the shoes out of contact with it. When the clutch is equipped with a shift collar, Fig. 10, the load may be started as with the simple automatic clutch, after which it may be stopped and started at will while the driving unit is operating at full speed. The shift collar permits a heavy load to be started with six shoes in the clutch. After the load has been accelerated, the shift collar can be used to disengage some of the shoes. This allows the clutch to slip at a lower torque, to protect the driven machine, than would obtain if all shoes were in contact. This combination gives in one clutch the dual features of high starting torque and low overload protection.

Overload Protection Only

For some drives, such as conveyors, stokers or others where there is danger of the load jamming, clutches may be used as overload protection only. One type of clutch for this purpose is shown in Fig. 11. Notched collar *C* is keyed to the driven shaft. Drum *D*, free of the driven shaft, carries a driving pawl *P*, a reset lever *L* and is bolted to a flange on the driving-unit shaft. As long as load remains within a predetermined limit, spring *S* holds driving pawl *P* in mesh with notched collar *C*, as in Fig. 11. When the load exceeds a safe value, pawl *P* is forced out of mesh with the notched collar and is held in this position by reset lever *L*, as in Fig. 12. The driving unit is now free to revolve until it is stopped, the cause of the overload eliminated and the clutch reset by screwing forward reset plug *R*. After the clutch is reset, the reset plug is returned to its original position. These clutches are available in sizes of from 0.25 to 200 hp. and may be built in as part of a coupling, sprocket, gear, V-grooved sheave or pulley, to accommodate any type of drive.

Power is indebted to the Washburn Shops, Worcester, Mass., J. P. Madden, Bethlehem, Pa., American Clutch & Equipment Co., Clifton, N. J., and Automatic Clutch Co., Inc., Chicago, Ill., for information from which this article was prepared.

Fig. 11 (left)—Safety clutch engaged for driving. Overload releases the clutch as in Fig. 12 (right)



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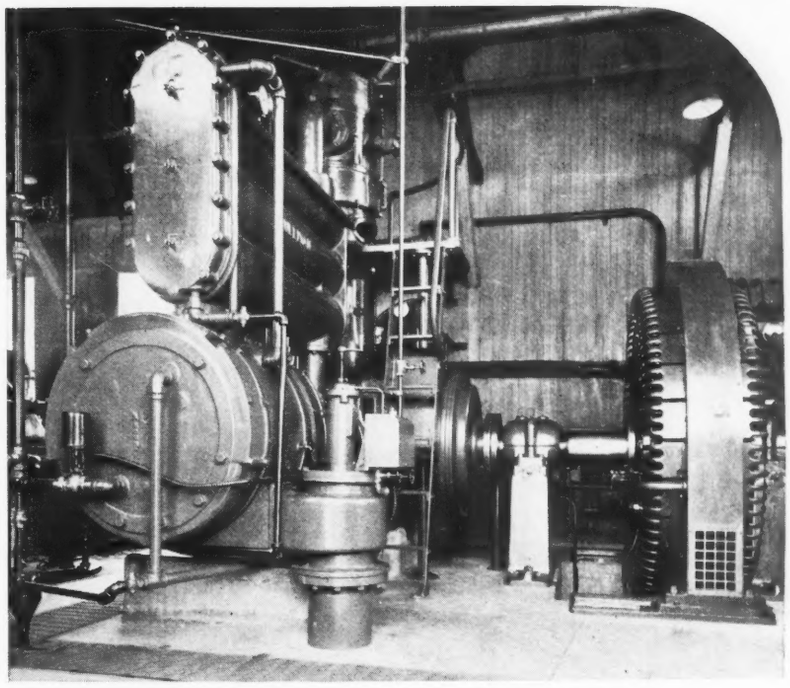


One-half of twin air compressor connected to synchronous motor by magnetic clutches and equipped with automatic intake unloading valves

How Air Compressors Are Unloaded

Here are the methods of regulating output of air compressors and factors to be considered when you select an unloading system

WHEN an air compressor is operated by a constant-speed drive, its output must be controlled by starting and stopping it or means must be provided for automatically unloading its cylinders. Methods of starting and stopping control were described in November, 1936, *Power,* page 605. In this article are considered unloading systems, such as automatic intake valves, holding cylinder intake valves open, and clearance pockets.

Fig. 1 shows one type of total-closure inlet valve. It consists of a cylindrical valve *V* held open by a spring *S*. On the upper end of the valve stem is a piston actuated by a pilot valve, Fig. 2, fitted to the top of the unloader. Receiver pressure is admitted under the pilot-valve thimble *T*, with the discharge leading to the top of the piston of the unloader. A slight increase above predetermined receiver pressure lifts the pilot-valve thimble *T* off its seat, admitting high-pressure air above piston *P* of the unloader valve and closes the inlet to the compressor. Desired air pressure is obtained by adjusting the tension of spring *S* on the pilot valve. To unload the compressor for starting, lever *L* is pulled up, permitting high pressure air from the receiver to close the unloader valve.

Another type of closed-suction unloader is shown in Fig. 3. *D* on the pilot valve, Fig. 4, connects to *D* on the unloader. When receiver pressure exceeds a predetermined value, it forces valve *B* off its seat, and admits pressure back of piston *P* in the regulator, which is mounted on the compressor intake. Receiver pressure on piston *P* closes valve *V* by forcing it to the left against the tension of the springs, and stops the air flow into the compressor. When the recevier pressure drops below a given value, spring *S* closes the pilot valve and releases the pressure back of piston *P* and springs S_1 open valve *V* to load the compressor.

In another method of regulation, the compressor suction valves are held open, and air entering the cylinder on the suction stroke is returned to the inlet pipe by the discharge stroke. An objection raised to this method is based on the assumption that when the valves close and the normal load is taken by the compressor, it produces a shock. This objection does not seem valid, since when the suction valves close at the beginning of the compression stroke the compressor resumes normal operation, excepting for the air in the clearance space of the suction side. This is at atmospheric pressure instead of receiver pressure in normal operation, and consequently does no work on the piston at the

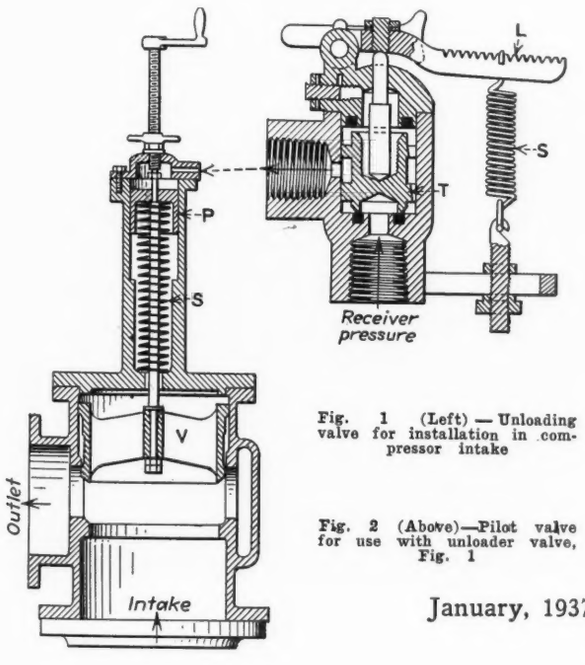


Fig. 1 (Left) — Unloading valve for installation in compressor intake

Fig. 2 (Above)—Pilot valve for use with unloader valve, Fig. 1

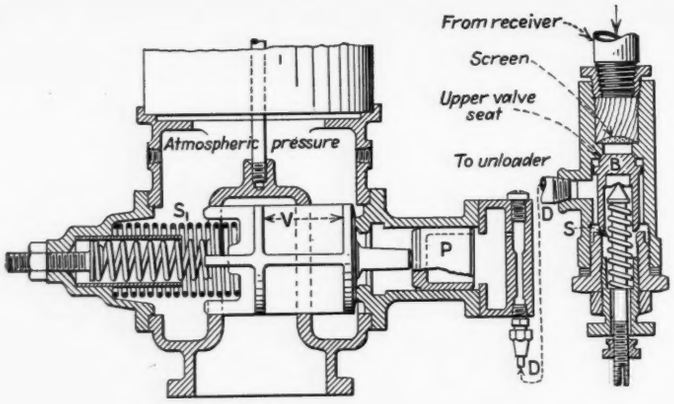


Fig. 3—Air-input regulator for mounting on compressor intake manifold. Fig. 4 (Right)—Pilot valve for use with the unloader, Fig. 3

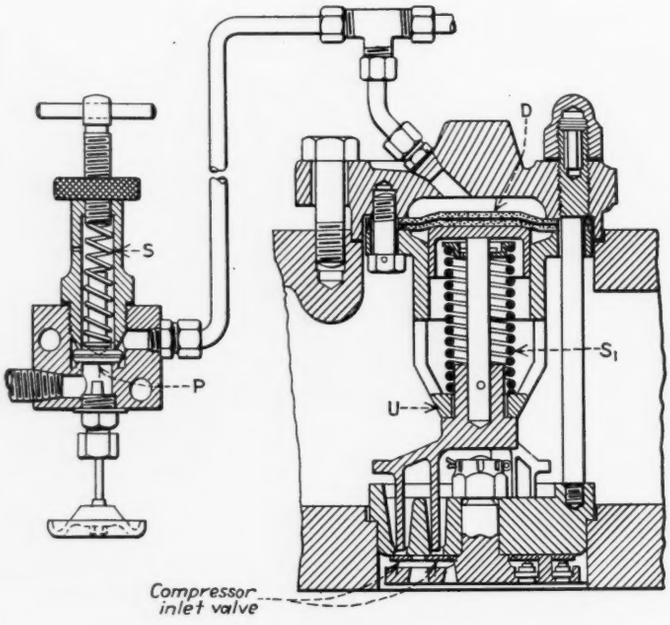


Fig. 5—System for unloading air compressors by holding intake valves open

beginning of the stroke. It is difficult to conceive of a load less likely to produce shocks than that of an air-compressor under normal operating condition, handling an elastic fluid like air, with the pressure increasing from zero to maximum in about three-fourths of the stroke.

Fig. 5 is a sectional view of an open-suction unloader. When receiver pressure rises above normal, the spring-loaded pilot valve P opens and admits high-pressure air from the receiver to above diaphragm D which moves the unloader U downward to hold the suction-valve disks off their seats, thus permitting the air entering the cylinder to return to the atmosphere without being compressed. When the pressure drops below a predetermined value, spring S closes the pilot valve and relieves the pressure above diaphragm D to allow spring S_1 to lift the unloader off the valves. A pilot valve is provided for each of the two intake valves and set for slightly different pressures, so that if the receiver pressure continues to rise after opening one end of the cylinder, the other end is then opened, completely unloading the cylinder. This system of unloading permits operating the compressor at 100, 50 and 0% capacity.

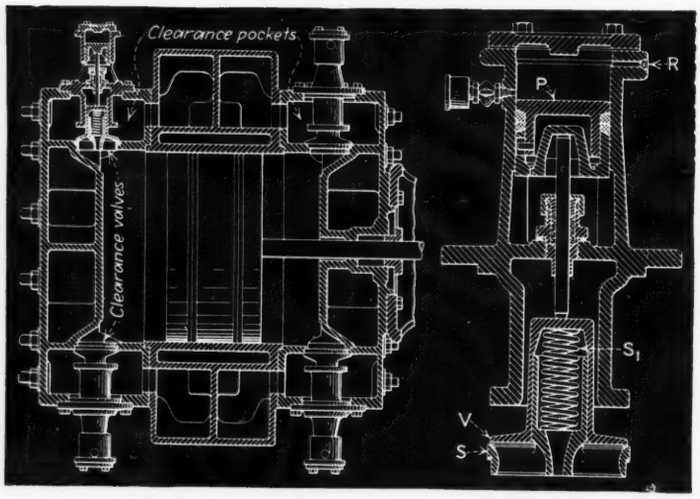
In the open-discharge-valve method of unloading, one or more of the discharge valves in each end of the cylinder is held open and the air goes back and forth between the ends of the cylinder. Obviously, the only work done on the air in this case is that resulting from friction in the passages. An objection to this method is that when the valves closed quickly and full load is suddenly taken on, it produces somewhat of a shock, depending on the position of the piston when the valves close.

Automatic Clearance Control

With automatic-clearance-control, receptacles or pockets are put into communication with the ends of the cylinder in stages, or steps, as the pressure in the receiver rises above normal. The air in these enlarged spaces is then compressed and re-compressed until normal operation is resumed. The reduction of capacity is effected by opening the pockets in the order of 75-50-25-0% output. The load is picked up in the reverse order; that is, in 25-50-75-100% output. This gives what is known as 5-step control.

In Fig. 6 is shown a horizontal section of a compressor cylinder equipped with clearance pockets and valves, and Fig. 7 is an enlarged section of one of the valves. Connection to the receiver is made at R. During normal operation, receiver pressure on piston head P holds valve V on its seat S. An increase of receiver pressure above a predetermined value caused an automatic control system to function and uncover ports that exhaust the high-pressure air from above piston P and the spring S_1 lifts valve V from its seat. The control system is so arranged that it puts the clearance pockets in communication with the compressor cylinder in their proper sequence, to give a 5-step control of compressor

Fig. 6—Cross-section of air compressor cylinder equipped with clearance pocket and valves for unloading in five steps. Fig. 7 (Right)—Automatic clearance-pocket valve of the type used in Fig. 6



output. The output of the compressor is controlled in this way:

Each cylinder has four clearance pockets, two in each end. If the compressor is running at full load and rated discharge pressure and the demand for air decreases, receiver pressure will tend to rise until, at a predetermined point the clearance regulator functions to open one clearance pocket in each cylinder. This allows approximately 25% of the air being compressed to pass into the clearance pockets and cuts the compressor capacity to 75%. On the return stroke, air compressed in the clearance pockets expands and gives up its power to the piston. If the demand for air continues to decrease another clearance pocket opens in each cylinder and the compressor capacity is reduced to 50%. Should the receiver pressure continue to rise clearance pockets will open to first reduce the compressor to 25% and then, to complete unloading, zero capacity.

Fig. 11 comprises indicator diagrams taken from a two-stage compressor equipped for five-step unloading. Opposite ends of the cylinders are alternately unloaded, as previously explained, through the various steps until at no load the diagrams are little more than lines, proving that the net work is only the equivalent of the heat passing through the cylinder walls.

Clearance Control Effects

An idea of how clearance control effects the desired results may be had from a study of the diagrams Figs. 8, 9 and 10. Fig. 8 shows a typical compressor diagram. The suction line does not depart from the atmospheric line, indicating no restriction to the flow of air into the cylinder. The receiver pressure is 80 lb. gage. The volumetric efficiency is 90% and n was assumed as 1.30. Fig. 9 is approximately what may be had from a compressor being unloaded by closure of the suction inlet. The air in the clearance space is compressed and re-compressed, and were it not for a portion of the heat of compression being absorbed by the jacket water, the diagram would be a single line traced and retraced, as in the figure.

The diagram Fig. 10 is from a compressor unloaded by means of clearance-pocket control. In order to begin the compression stroke at atmospheric pressure, the normal clearance is increased by the volume represented by the rectangle *C, D, E* and *F*. And, as in the case of Fig. 9, the diagram would be the single line shown, were it not for heat transfer to the jacket water. The lower diagrams, Fig. 11, show the effect of heat transfer to the water and to the surrounding air. Compressing the air imparts to it the heat equivalent of the work performed. Heat is constantly being emitted from the cylinder, so on the return, or suction stroke, the line falls away from the compression line. Obviously then, whatever the method of unloading, some unrecoverable work is done on the air; a slight loss, however, which is represented by the areas of the lower diagrams of Fig. 11.

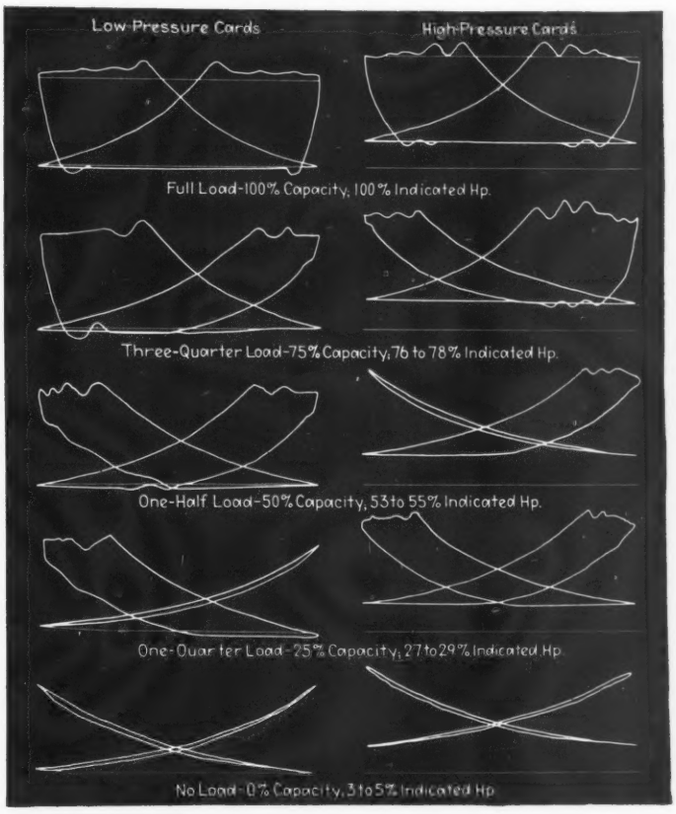
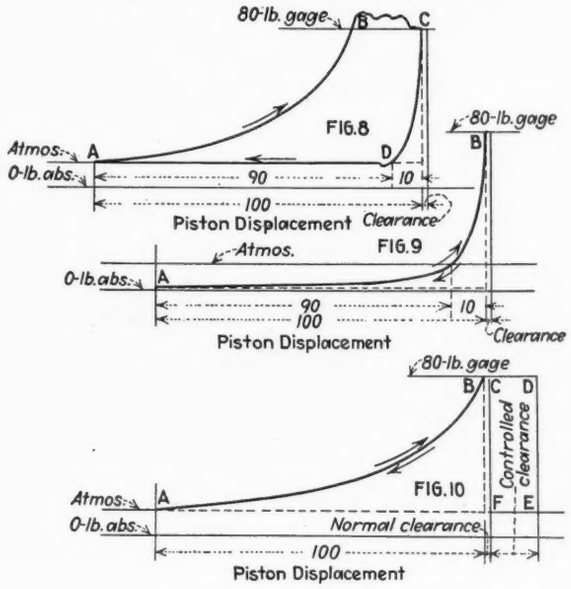

Low-Pressure Cards
High-Pressure Cards
Full Load-100% Capacity, 100% Indicated Hp.
Three-Quarter Load-75% Capacity, 76 to 78% Indicated Hp.
One-Half Load-50% Capacity, 53 to 55% Indicated Hp.
One-Quarter Load-25% Capacity, 27 to 29% Indicated Hp.
No Load-0% Capacity, 3 to 5% Indicated Hp.

Fig. 11—Indicator cards showing operation of 5-step unloading with cylinder

Figs. 8 to 10—Diagrams showing how clearance-pocket control affects compressor operation



The next article will discuss the choice of unloading systems.

The author is indebted to the Worthington Pump and Machinery Corp., Harrison, N. J., Ingersoll-Rand Co., New York City, Sullivan Machinery Co., Michigan City, Ind., Gardner-Denver Co., Quincy, Ill., Chicago Pneumatic Tool Co., New York City, and Schramm, Inc., West Chester, Pa., for assistance in the preparation of this article.

▼

DARLING Owns the Boiler— MILLER & HART the Engine

Darling & Co. had cheap steam but couldn't use it. Miller & Hart, 900 ft. away, needed cheap steam but couldn't make it. Darling & Co. needed steam for process; Miller & Hart could return exhaust for heating feedwater. Now Darling's boiler runs Miller & Hart's engine, and both save money

MILLER & HART, Inc., packers in the Union Stock Yards, Chicago, have a power plant, the older parts of which are more than thirty years old. The boiler room contains four 2,500-sq.ft. stoker-fired boilers. The engine room contains one engine-type generator, two motor-driven 1,200-ton ammonia compressors, and a 100-ton absorption unit. There are also the usual air compressors, etc.

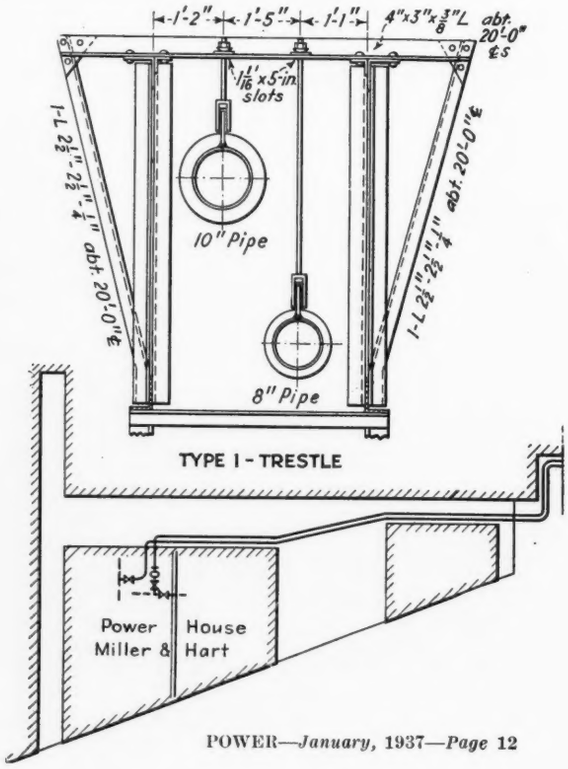
The firm early in 1936 called in consulting engineers to analyze the general power situation. A good part of the equipment in the engine room was reasonably modern, and all of it was in good operating condition. The plant was competently handled, and adequate records had been kept in recent years to give a satisfactory picture of just what was happening. It was found that the boilers and stokers were not only old, but obsolete. Coal- and ash-handling equipment was clumsy and boiler-room maintenance costs were unavoidably so high that they were ridiculous. This was a situation which could not be corrected except by entire redesign of the boiler plant. Rebuilding the boiler plant, and at the same time maintaining service with a load frequently well above 30,000 lb. of steam per hr., was an expensive as well as a difficult undertaking.

The neighboring plant of Darling & Co. contains four 5,000-sq.ft. boiler units of a fairly modern type. This plant, owing to changes in operation since construction, had such a light load that efficient operation was not obtainable and the owners were anxious to get additional load. So a contract arrangement was worked out for the purchase of steam by which Darling & Co. operates its boiler plant under a joint cost arrangement for the benefit of both users.

A 10-in. outdoor steam line carrying 150-lb. pressure has been constructed to connect these two plants. For the present, at least, this will be saturated steam. As Darling & Co. uses practically all of its steam in process, there is little exhaust available for feedwater heating, so an 8-in. low-pressure exhaust main has been run from Miller & Hart's back to Darling's feedwater heater. While there may not be sufficient exhaust available at times, during a great part of the year Miller & Hart's exhaust steam will be adequate for feedwater heating.

This line is somewhat less than 900 ft. long. Reference to the plan shows how the steam line for two-thirds of its length is carried on the existing Miller & Hart buildings, which are generally five and six stories in height, but the south end of the line crosses a street, some switch tracks and some low buildings. On the main Miller & Hart buildings, the two lines were carried on wall brackets. The north end of the line has the exhaust resting on the

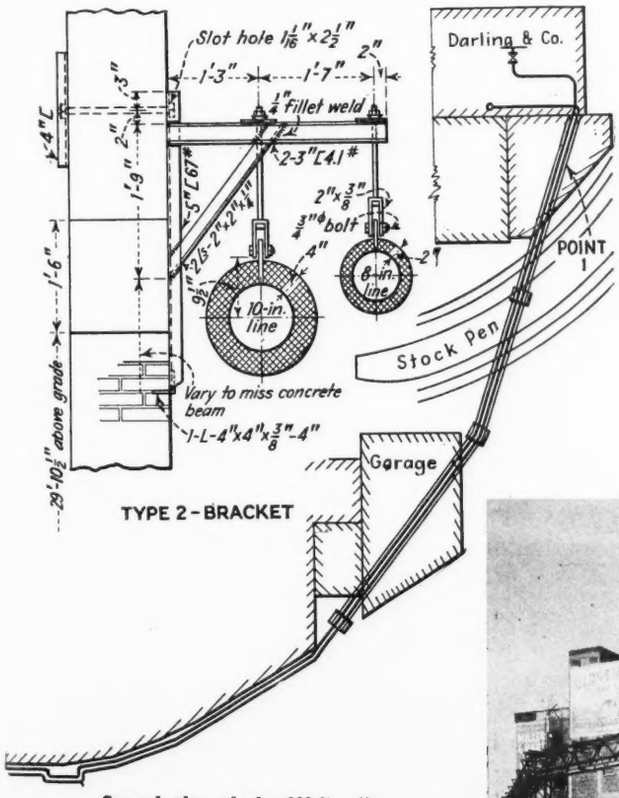
The line at Point 2, nearing Miller & Hart's power plant and supported from building brackets of Type 2



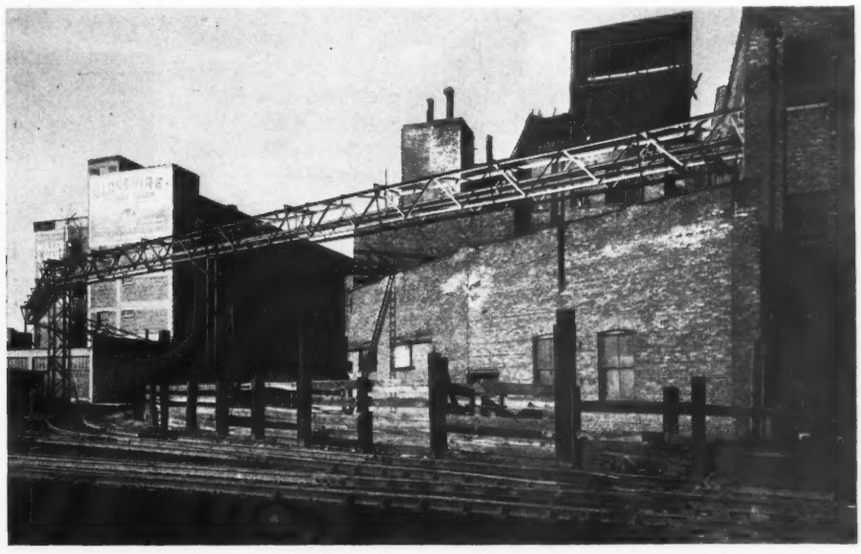
top of existing concrete girders, with the steam line suspended below them. At these points the higher line is carried on chairs welded to the pipe. All remaining piping is suspended by means of slotted lugs, welded to the pipe at each point of support. Crossing the street, etc., are three truss spans carried on three steel towers and on the wall of the Darling boiler house. The longest of these spans is 115 ft. Trusses are lattice box girder in design, open at the bottom to facilitate hoisting pipe, and the pipes are suspended with the same type of hanger as on the brackets. The height of this girder is such that it is possible to pitch the steam line downward from Darling's plant to the engine room and at the same time to pitch the exhaust line downward from its original rise at Miller & Hart's plant to the heater in Darling's.

Outdoor portions of the lines are entirely of welded construction. Both lines are insulated with magnesia, the exhaust line with standard thickness and the steam line with standard thickness plus lagging to a total thickness of $2\frac{1}{2}$ in., and both are covered with asphalted asbestos roofing. The lug supports give a minimum area of metal penetration through the insulation.

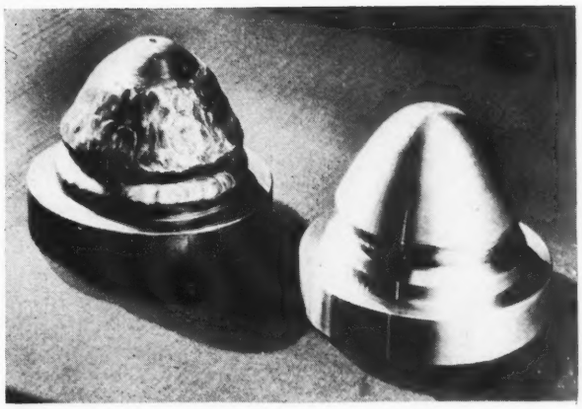
The piping contract was executed by Wm. A. Pope Co., bridges and towers by Mississippi Valley Structural Steel Co., and insulation manufactured by Johns Manville Co. applied by Illinois Roofing & Insulation Co. The consulting engineers were W. L. Fergus & Co., Chicago.



General plan of the 900-ft. all-welded steam lines and details of the trestle cross-section and of a typical building bracket



The pipeline at Point 1 where it leaves Darling & Co. on an overhead trestle of Type 1, crossing tracks and roadway



Permanent Seat

VALVES handling feedwater at 1,500 lb. per sq.in. must be made of carefully selected materials. A recent installation of several 6-in. globe throttle valves in a 1,400-lb. steam power station is a good example. Valve bodies were specified to stand a 3,500-lb. hydrostatic test. However, despite this and the fact that the disks weighed over 50 lb. each, the valves can easily be operated manually.

To insure economy in operation, and to avoid replacements of disks and seats, seating surfaces were hard-faced with a cobalt-chromium-tungsten alloy. The disks (above) were of forged 13% chromium steel. After disks and seats were hard-faced, they were ground to a parabolic contour to provide, in service, equal increments of flow for equal movements for the handwheel.

Valve trim of this non-ferrous alloy is used for all types of gate, globe, angle, check, needle, safety non-return, blow-off and regulating valves where operating conditions demand that the seat and disk material be free from seizing and galling and also be corrosion resistant. Where predetermined flow is desirable and where operating conditions are severe, as in this case, use of hard-faced disks and seats avoids frequent repairs and replacements.

Alloys of this type are applied with the oxy-acetylene blowpipe. One or two types may also be applied with the arc. Shaping and finishing must be done by grinding.

Oil Circuit-Breaker Maintenance

How to keep medium-voltage oil circuit breakers in good operating condition and prevent unexpected failures

By K. B. Humphrey

Sayreville, N. J.

OIL circuit breakers are used on all medium- and high-voltage a.c. circuits and sometimes on 440-volt, or even lower-voltage circuits. They are not only used to open and close transmission and distribution lines but are frequently applied to motor and other equipment circuits. For safe and reliable operation of oil circuit breakers, it is necessary that oil, contacts and other parts be maintained in good condition. This article will discuss these elements of switches for 2,300 volts or less.

Circuit-breaker oil should be pure mineral, free from moisture, acids, alkali, or free sulphur, with low viscosity, resistant to emulsion, and with little tendency to form sludge. If obtained from a reliable manufacturer, it will generally be free of moisture when received, unless the container is damaged in shipment. Moisture is the most undesirable contamination, and even in quantities as small as 20 parts per million by volume, seriously reduces the insulating value (dielectric strength) of oil, Fig. 2.

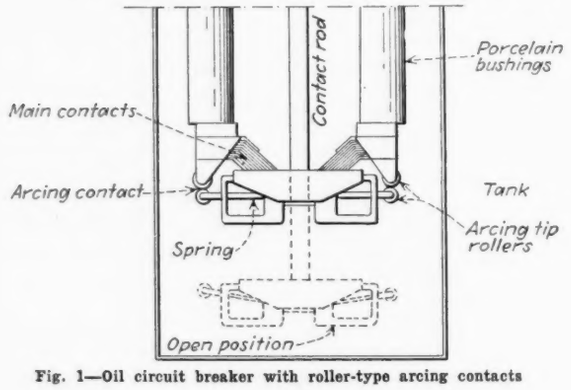


Fig. 1—Oil circuit breaker with roller-type arcing contacts

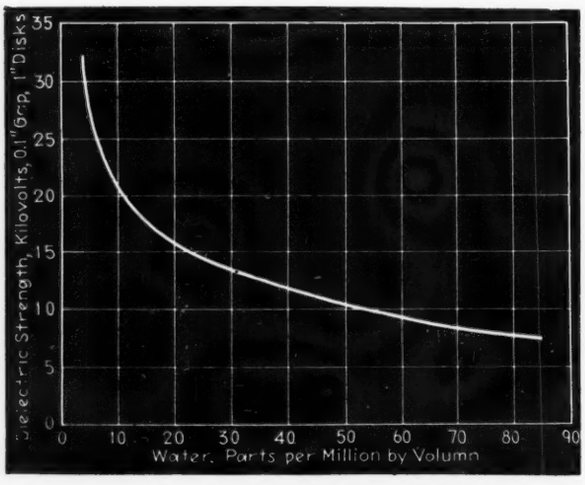
Oil should be maintained so that it will test above 20 kv. by the standard test. Minute quantities of acid, alkali, or free sulphur will cause pitting and corrosion of copper parts. Contamination of this sort is uncommon in insulating oil. Low viscosity is necessary for quick quenching of the arc, and to circulate freely to carry off the heat from the contacts. Resistance to emulsion, together with low viscosity, allows moisture entering the apparatus, or carbon-formed, to settle readily to the tank bottom, where it will do least harm. Resistance to sludging or oxidation is of less importance in circuit breakers than in transformers, where for other reasons the oil should be processed or renewed before appreciable sludging can occur.

Chief causes of oil deterioration in operating circuit breakers are moisture and carbonization. Moisture may get in accidentally, as from a leak in the roof or from moist containers. Most moisture comes from condensation on metal parts above the oil level and on its surface. Carbonization is caused by arcing between contacts, which breaks down the oil and forms carbon in very fine particles. Part of this settles on the bottom and other parts of the breaker, part remains in suspension. Carbon reduces the insulating qualities of the oil and its resistance to emulsification and, in combination with moisture, reduces surface insulation of breaker parts. Carbon is formed more rapidly in cold weather than in hot and does not settle out as readily because of higher viscosity at lower temperatures.

A thorough periodic inspection is essential. Depending upon service, the maximum time allowed between inspections ranges between 3 and 6 mo. Renew or recondition the oil at least once a year or sooner, if dielectric strength falls below 17,500 or 18,000 volts. The standard spark gap for the dielectric test is 0.1-in. flat electrodes, 1 in. in diameter, arranged in a cup to hold the oil. Details of apparatus and methods are given by manufacturers. The test is started at a low voltage and increased at approximately 3,000 volts per sec. until the oil breaks down. Five tests are usually made for each filling of the cup, and the mean of the average of three fillings taken as dielectric strength. When it falls to 20,000 volts, the oil should be regarded with suspicion and not be allowed to go below 17,500 or 18,000. Good oil breaks down at about 30,000 volts.

In many plants, the small number of circuit breakers in service does not economically justify any great investment for testing apparatus or oil-purifying equipment. Industrial plant engineers may send a sample of oil to the manufacturer for test, or perhaps the utility company, if power is purchased,

Fig. 2—How dielectric strength of insulating oil is affected by water



will test the oil. On the other hand, plant engineers may rely on their own judgment and change oil regularly so that there will be little chance of a switch failure.

In all cases, regular inspections should be made at no less than 3-mo. intervals if testing equipment is lacking, and mechanical repairs should be made at the same time. In addition to regular inspections, a circuit breaker should be inspected after opening a short circuit or heavier-than-normal current. Quoting from the A.I.E.E. Standards for Oil Circuit Breakers: "After performance at or near its interrupting rating, the interrupting ability of the breaker may be materially reduced, and it is not to be inferred that it may be reclosed after such performance without inspecting, and if necessary, making repairs."

Some circuit breaker manufacturers recommend that oil be changed or filtered and the porcelain and other parts cleaned every 6 mo., or oftener if the service is severe. A dielectric test will not always show the presence of moisture in the tank bottom. When free moisture is present, traces of moisture or even rust spots may appear on the underside of the tank cover. If this condition is found, change oil before putting the breaker back into service.

Water may be detected in new oil by the saucer test, which while by no means conclusive, may save some trouble and prevent the use of poor oil. A small quantity of oil is placed in a dry saucer and heated rapidly to a temperature of about 250 deg. F. A crackling sound indicates the presence of water. This test should not be used on old oil. There is no conclusive simple test for the dielectric strength of oil, but bad oil will be indicated by an excessive heating of the switch tank after the switch has been closed for a time. This oil is in no condition to be used and should be renewed or reconditioned at the first opportunity. When inspecting the oil, see that it is at the level marked on the switch tank, for a low oil-level may mean a flashover.

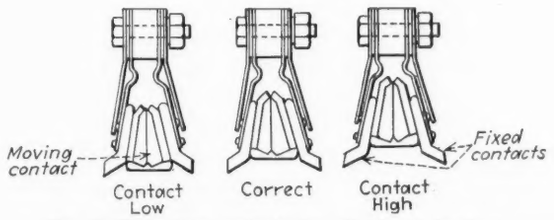


Fig. 3—Wedge-type contacts for oil circuit breakers

If filtering or purification apparatus is not available, and this is the case with all except the larger users of oil-filled apparatus, the oil should be changed at least once a year. While it seems rather a waste to throw the oil away, this is preferable to risking a serious interruption of service or a possible injury. In some cases, arrangements may be made with the utility company to filter and condition the oil, if saved in clean containers.

Carbonization is indicated by a black flaky precipitate which floats in the oil when disturbed. Appreciable amounts of carbon will decrease dielectric strength and deposits will form on the insulating bushings and submerged breaker parts. Carbon and

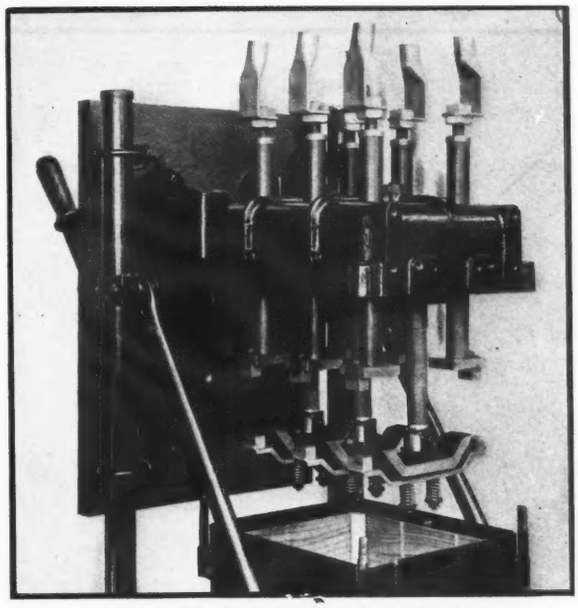


Fig 4—Oil circuit breaker with laminated main contacts and block arcing contacts

moisture together form a coating on the porcelain bushings which lowers the insulating resistance between line and ground, and may result in a flashover. In case of leakage, heavy enough to be heard outside the tank, leave the breaker or compensator closed until the load can be taken off and the circuit opened ahead of the switch if possible. In no case should the switch be closed again before the oil is either reconditioned or changed and the switch parts cleaned.

Thoroughly clean all parts at each inspection. This can best be done by swabbing with insulating oil and wiping off with a clean cotton cloth. Waste or cloth that sheds lint should not be used. Gasoline sometimes used for cleaning, is not particularly good, as it may contain moisture.

Contacts should be examined at frequent intervals, usually every 3 mo., oftener if the service is severe, and after they have opened a heavy short circuit or overload. Contacts should bear with firm and even pressure and should all meet at practically the same time.

Some means is usually provided so that arcing does not occur on the main current-carrying contacts. Pitting is therefore confined to easily-renewed auxiliary parts where it does not interfere with current-carrying capacity. Arc tips should be renewed before they cause pitting on the main contacts, as badly pitted contact surfaces may cause heating. Contacts may be trued with a fine file when necessary and a finishing touch given with a piece of fine sand-paper. It is the practice in some plants to replace all contacts that show excessive pitting, and slightly-worn ones are trued up in the shop during spare time and used again. When a breaker is not being operated regularly, experience shows that operating it at least once every two weeks will prevent oxidation of the copper contacts, and materially improve their operation.

Contacts are made in many styles, sizes and types for different kinds of service. Fig. 1 shows one type designed to handle from 600 to 1,200 amp. The arcing contacts are in the form of stationary rollers

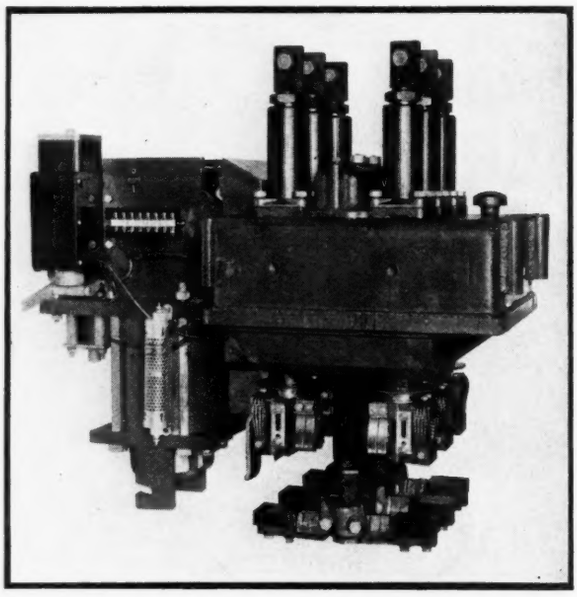


Fig. 5—Oil circuit designed for particularly severe service in industrial plants

which may be rotated to present a fresh surface and locked in the new position. This type has been superseded by a breaker using an arc-enclosing device of special shape and construction which permits many more interruptions before requiring inspection and renewal of contacts. The main current-carrying contacts of the bridging members are wedge-type with silver-plated contact surfaces.

Another type for control and protection of synchronous and induction motors where the starting duty is severe has laminated-brushes contacting stationary members of heavy copper blocks. The butt arcing contacts are easily removable and self aligning, Fig. 4. A wedge contact is shown in Fig. 3 in three different positions, the middle one being correct. Contact and arc tip are in a single piece, and when they become pitted, the whole contact must be replaced. One set of contacts sometimes pits faster than others in the same breaker. This is probably because they come in contact at different times, and indicates that adjustments should be made.

Fig. 5 shows a breaker designed for heavy-duty, steel-mill service for cutting down contact maintenance to a minimum. Main current-carrying contacts are of the finger-and-wedge type, protected by massive-block arcing contacts of specially treated copper capable of withstanding burning incident to frequent operation and arcing and automatically adjustable to burning away of the contact surfaces. Shunts are arranged so that current through them produces a magnetic field to assist the compression springs in maintaining good contact pressure. The oil-blast principle assists in cutting down contact maintenance because of the short duration of the arc.

What has been said about oil and contact maintenance of circuit breakers applies equally for oil-filled motor-starting compensators. The compensator is nothing more than a special type of oil switch. As the clearances are usually less, it is doubly important to keep them clean and to see that all insulating surfaces are kept free from carbon deposits.

The chief points for maintenance of oil circuit breakers are summarized below:

1. See that breaker is disconnected from all sources of power before inspection.
2. Check oil level.
3. Check oil (by inspection or test); change if necessary.
4. Check contacts for pitting and wear.
5. Check tightness of connections to line or motor.
6. Check mechanically the operating mechanism for tightness of nuts, undue wear, and adjustment. Lubricate with lubricating oil.
7. Clean all surfaces where carbon is deposited.
8. If overload relays are used, see that they are working properly.

To facilitate regular inspection, it is a good plan to make a record for each oil-filled breaker or compensator showing the date inspected, condition, and any repairs or changes made.

EXHAUST LINES

By E. J. Tangerman

"Old Ironsides", historic 54-gun frigate launched in 1797 as the "Constitution", is now berthed in Charlestown, Mass., Navy Yard on exhibition. So that visitors can look her over during the winter months and to prevent checking and shrinkage of timbers such as would result from normal heating, her gun and berth decks have been winter air-conditioned, using a duct and spray system with outlet grilles. Humidity is held at 30 to 35%, with 70 deg. F. dry-bulb. Unit heaters are also used when temperature goes below 20 deg. F. The whole installation can be taken apart and put away in summer.

Developed water power in Sweden at the beginning of 1936 had a turbine capacity of 1,449,000 kw. This represents an increase of 254,000 kw. compared to 1929. Water power in the course of development, and not included in the above figures is estimated at 122,000 kw. Water power stations in Sweden at present number 1,373.

Reports are that 39,822 engineers attended the recent Power Show.

Wrought iron seems to have its place—in a variety of places. Its use for metal power-plant stacks has been carried over to diesel exhaust piping and mufflers. The average amount of piping used in cooling coils for the skating rinks at Princeton, Madison Square Garden, Atlantic City Auditorium and Chicago Stadium is enough for the plumbing systems in 116 average-size homes. During the recent Ice Show at the Garden, refrigerating equipment was operated at capacity all the time, both to cut down melting of the shaved-ice imitation snow and to give spectators that "winter sports" feeling.

"Bluenose", undefeated champion of the North Atlantic fishing fleets and holder of the International Fishing Schooner Trophy since 1921, has been equipped with two 90-hp., 2-cycle, 3-cyl., 8¾x10½-in. solid-injection Fairbanks-Morse diesels.

Of the 140 towns and communities which have voted on PWA loans for power plants, these are the results: Towns under 10,000 population, 98 favorable, 17 unfavorable; towns of 10,000 to 99,000 population, 13 favorable, 7 unfavorable; towns of 100,000 to 599,999 population, 4 favorable, 1 unfavorable. This gives a total of 115 favorable (82%) and 25 unfavorable.

Providence, R. I., is among the cities which have recently begun to produce power from garbage. The installation there is a turbine plant, to save $100,000 a year.

New Boiler for Defiance Milk

By Ralph A. Spengler

Consulting Engineer

DEFIANCE MILK PRODUCTS CO., Defiance, Ohio, evaporates large quantities of milk and sells steam and refrigeration to the neighboring Crist Diehl Brewing Co. Daily steam-demand curves vary through the year, reaching a maximum in summer. 10,000 lb. per hr. is the average summer night load. From 8 a.m. to 10 a.m., load rises to almost double that at night. In the next five hours, average load is 28,900 lb. per hr., with peaks reaching 34,000 lb. per hr. After 3 p.m., load drops off rapidly.

Steam was being generated at 115 lb. pressure by three boilers, evaporating about 7 to 7½ lb. of steam per pound of coal. Repairs to these boilers became increasingly costly, and operation more and more uncertain. As this plant must operate seven days a week, continuity of service is essential.

Enlargement of the boiler room was the first step. A space behind the boilers was excavated and a new boiler-room wall built. Walls of the old boiler room were carried up approximately 12 ft., and a whole new roof built. This space was created to house pumps, heater and water-treating equipment.

It was necessary to put in a new boiler with sufficient capacity to carry the entire load, with a furnace designed to burn efficiently low grades of fuel. This involved consideration of floor space, water treatment, elimination of oil from returns, and non-interference during replacement.

One h.r.t. boiler was replaced by a new 4-drum bent-tube, 4,220-sq.ft. boiler. The mud drum was set 10 ft. from the floor, with the furnace chamber designed to operate at 250% rating without damage to brickwork. A multiple-retort, underfeed stoker, having a projected grate area of 90.2 sq.ft., was used. Furnace of the all-firebrick setting was lined with Missouri brick, two rows of Bernitz blocks in front and side walls, and three rows above the dump-plate line on the bridge wall.

The brick stack for the old boilers was not high enough to produce natural draft for the new boiler, so an induced-draft fan was installed in the breeching. A bypass cuts out the fan and permits the boiler to operate on natural draft when load is at rating or below.

Coal-handling equipment previously consisted of a narrow-gage track and dump car. In its place was installed a receiving hopper and bucket elevator of 20-ton-per-hr. capacity to load coal into a 15-ton storage bin over the new stoker. Distributing chutes carry coal to the two h.r.t. boilers, which serve as standby. Later, they will be replaced with one like the new unit.

The rear of the boiler was under-cut and the ash pit placed below floor level. When ashes are not being removed, a hinged grating covers the ash pit. Ashes are removed with bucket and electric hoist after the grating is swung out of the way.

During the day, the majority of the condensate, carrying oil from the engines and pumps, is returned to an open heater about 14 ft. above the level of the boiler-feed pump. To remove this oil, two large filters were installed. Water flows from the heater through the filter to the boiler-feed pumps.

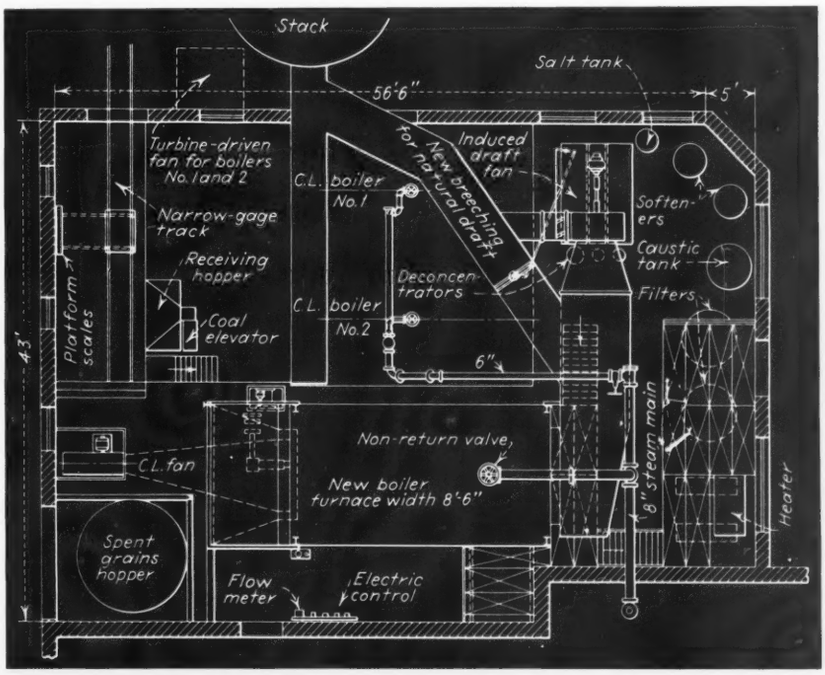
City water, used for make-up, varies throughout the year from 11 to 21 grains hardness, much of it permanent. A zeolite softener gives zero-hardness makeup water, and deconcentrators are installed.

The boiler went into operation in April. After a month's run, an inspection was made, and drums and tubes found in good condition. By careful treatment and analysis of boiler water two or three times a day, the engineer is assured that scale is not forming and that no corrosive agents are in the boiler. This boiler is carried on the line for six months. Then an inspection is made.

A Ruggles Klingeman pressure controller was used on the h.r.t. boilers and was reinstalled on the new boiler to control the uptake damper and stoker speed. A Hagan overfire draft control is used to regulate speed of the forced-draft fan. This arrangement has given good results at low cost.

Steam output is measured by a boiler-flow meter. A second pen to record air flow is contemplated. Feedwater is controlled by a water-level regulator and pump governor, which have maintained a satisfactory water level in the boiler.

The boiler responds satisfactorily to rapid fluctuations in load; it will go from 100 to 200% rating without loss of more than 1 to 2 lb. pressure. Average evaporation of steam for July showed 10.3 lb. of steam generated per pound of coal.



Detroit Edison *Salvages* 150 Tons of Insulation

When Delray 1 and 2 were dismantled, 150 tons of broken pipe covering were stored. Now this has been remolded for use in rebuilding Connors Creek, at a considerable saving

By E. T. Cope

Detroit Edison Co.

MOST of the materials and equipment from an obsolete power plant to be dismantled must be disposed of as scrap and gotten out of the way at least possible cost. Materials and equipment removed when Delray Power Plants No. 1 and No. 2 were dismantled were no exception to this. Magnesia covering taken from steam and hot-water piping, however, was not disposed of as scrap, but nearly 150 tons of it have been reclaimed and reused as insulation on boiler drums, economizers, hot air ducts, breeching, etc., in rebuilding the Connors Creek Power Plant. The cost of reclaiming this magnesia was about one-third of the cost of new material of the same insulating value.

During the dismantling of the plants it was possible to remove some of the covering from the pipes without serious breakage, yet there were tons of broken pieces which could not be economically reused as they were. This broken covering was stored in bags which made an immense pile in a large shed. Disposal of it to advantage presented a real problem in that it was necessary to determine whether it was worth saving, and if so, in what form it could be used. A portion of the covering was shredded in a grinder and used for insulation under the roofs in warehouses and in a few smaller buildings on Company property. Still a great pile of bagged, broken covering remained on hand.

The idea occurred that the shredded covering might be mixed with water and molded into blocks and these blocks might be used instead of new block covering. Some sample blocks were made by mixing the shredded covering with as little water as would produce a moldable mixture and molding it in boxes 6 in wide, 36 in. long and 1¼ in. deep. The water was driven out by heating on an ordinary steam radiator. Tests were carried out in the Research Laboratory to determine the ability of the blocks to resist handling; the thermal conductivity compared with new magnesia block; the rate of weight loss due to continuous heating at 400 deg. F. for 150 hr. and also 600 deg. F. for 150 hr., and the lowest water-to-magnesia ratio for a moldable mixture.

Results of these tests showed that, while the ability to resist handling was only about half that of new 85% magnesia block of the same size, yet, if the blocks were cast to full covering thickness (2½ or 3 in.) and 6 in. wide by 18 in. long, the strength would be ample for practical purposes. Tests to compare the thermal conductivity of reclaimed block and new 85% magnesia block showed that the reclaimed block transmitted heat at a rate about 10% in excess of that of the new material. The rate of weight loss upon heating continuously for 150 hr. at 400 deg. F. was the same for both new and reclaimed material and at 600 deg. F. was about 80% as much for the reclaimed block as for the new. This rate of loss gives some idea of the rate of deterioration and loss of mechanical strength of the covering. The lowest ratio of water to shredded covering was found to be 3 to 1, i.e., 3 lb. of water per lb. of shredded covering was the smallest quantity that would produce a readily moldable mixture.

The results of the tests were so encouraging that the construction of a plant to produce blocks 2½x6x18 in. and 3x6x18 in. was immediately undertaken. This entailed building a drying equipment, making about 600 pans in which to mold blocks, and arranging a mixing box with water supply.

It would have entailed considerable capital outlay as well as some delay to have bought and assem-

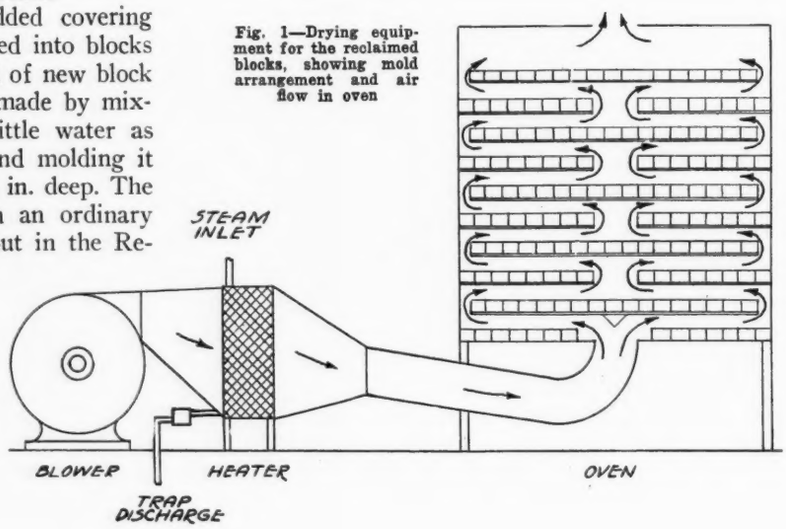


Fig. 1—Drying equipment for the reclaimed blocks, showing mold arrangement and air flow in oven

Fig. 2—A pile of finished blocks stored near the mixing and drying equipment

bled the necessary equipment. In consequence, the salvage warehouse and the scrap pile were examined. A discarded weighing tank was found. This appeared to be just the thing for the shell of the drying oven. This tank, about 5x6x9 ft., was open on one 6x9-ft. side. Iron doors were hinged to the open side. Steel shelves having holes in them to permit air circulation were welded at proper spacing. An entrance vent at the bottom and an outlet vent at the top were cut, and the oven was ready to be connected to the blower and air heater.

An effort was made to calculate the size of heater and fan capacity. Calculations were carried out correctly, but the nearest available size of air heater and fan did not produce just the results desired, so that some adjustment had to be made in these parts of the equipment. The second trial of fan capacity and heater size resulted in satisfactory performance. Heaters consisted of two used auto-truck radiators, borrowed from the Company garage. The fan was borrowed from the salvage machinery warehouse. A little ductwork sufficed to connect the fan and heater with the drying oven, and after the heater, ducts, and oven had been well insulated to reduce heat loss, the equipment was ready to go. Fig. 1 shows the drying equipment.

For mixing boxes, two mortar boxes were borrowed from a construction job. Steel barrels with large discharge valves for measuring water were erected on elevated supports. To simplify proper proportioning of water to shredded covering, trials were made by weighing out the water and covering and noting the volume of covering necessary to be mixed with the water in one filling of the water tanks. No further weighings were made.

The shredded magnesia and water were thoroughly mixed by hand in the mixing boxes and allowed to stand overnight. There were two reasons for allowing the mixture to stand: first, to arrange the operation of making blocks so that a minimum number of men were continuously required; second, to give the mixture time to become thoroughly soaked.

The steel molds, made from 16-gage plate, welded at the corners, were filled by hand and placed on a shaking table where the air was shaken out. This shaking table was inclined a little so that the filled molds would slide readily toward the edge of the finishing table. An air drill operating a cam shaft was used to shake the table. On the finishing table, the top surface of each mold was smoothed with a trowel. The filled molds were then either placed in the oven, if the oven was empty, or were stacked in a convenient place, if the oven was not ready to receive them. The arrangement of molds in the oven is indicated by the horizontal rows of rectangles and air flow by the arrows in Fig. 1.

The oven, when filled, held about 600 molds, which yielded about 2500 lb. of dried blocks ready for use. The equipment produced two batches or about 5,000 lb. of finished blocks per week. These blocks were smooth enough and of sufficiently uniform thickness to require no trimming, Fig. 2.

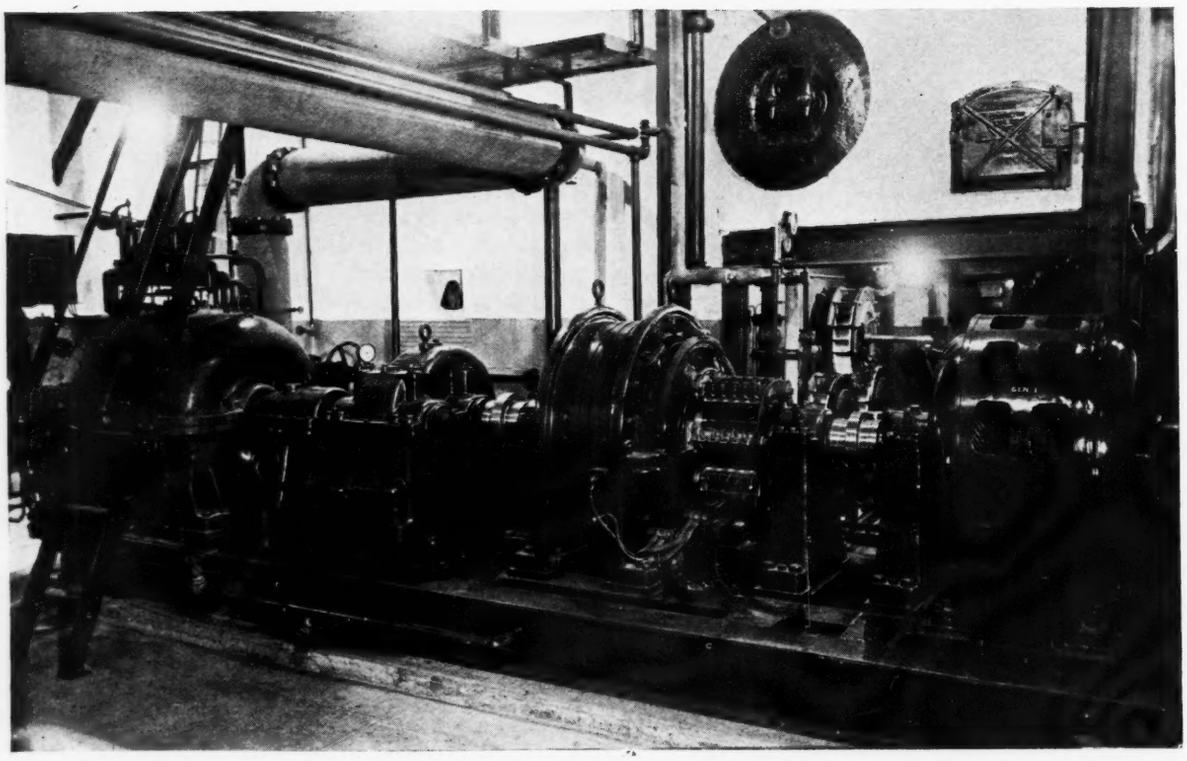
A few details may be of interest. The steel molds to produce $2\frac{1}{2}$x6x18-in. block were $2\frac{3}{16}$x6$\frac{3}{8}$x19$\frac{3}{16}$ in., and to produce 3x6x18-in. block were $3\frac{1}{4}$x6$\frac{3}{8}$x19$\frac{3}{16}$ in. Labor required was about 36 man-hours per ton of finished blocks. The help was common labor. The shredding machine was a disk grinder without name, taken from salvage and adapted to the shredding work. Mixing and drying equipment was erected close to the ash-tunnel track in Plant No. 2, where water, low-pressure steam, and electricity were available, and a railroad track was handy.

Pipe coverers show a preference for the reclaimed blocks. The reasons given by them are: They are of convenient size for handling; they do not break badly, yet are soft enough to be fitted readily to irregularities; and especially are less dusty to handle.

Packing May Pit Stainless

ALTHOUGH stainless steel is not corroded by many gases, liquids and solids, leather packing has a definite corrosive action caused by electrolysis. Salts used in tanning, and thereby impregnated into the leather, combine with water absorbed from the atmosphere to set up an electrolyte, pitting the steel. Interesting is the fact that pitting does not take place when the steel is moving through packing—only when a shaft or rod is idle.

Leather is not the only material which causes such pitting. Other packing materials, such as flax or hemp, usually impregnated with grease or wax filler made from a soda or lime base, contain salts which result in electrolysis. This corrosion can be eliminated by impregnating the packing with a filler which neutralizes the salts, thereby nullifying any electric charges. Also, remember that a dissimilar metal used with steel will also cause pitting through electrolysis. Supporting or bushing rings should be of the same metal as the shaft.—Abstracted from *Research Illustrated.*



Generator and alternator, which furnish all power, are mounted on a single shaft and driven by a 350-kw. Elliott turbine. Boiler burners, recessed under drums, can be seen in background. Boiler and generating set occupy but 28x28 ft. Steam is taken at 200 deg. superheat, 150 lb., exhausted at 1 lb. gage to exchanger which heats water for the laundry

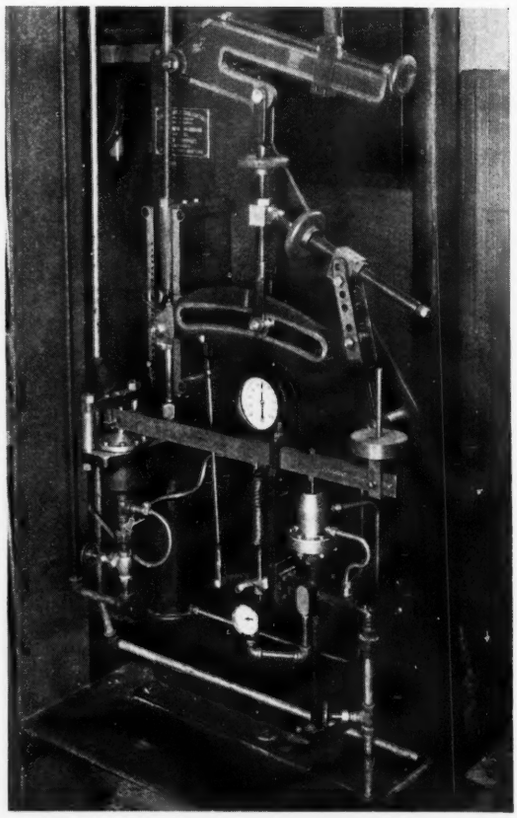
Isolated Power Plant Cuts Laundry Operating Costs

Increased boiler pressure balances heat and power load and gives higher efficiency in less space. Diesel set carries night loads

AN INSTALLATION which ended electric standby charges, improved plant efficiency and economized on floorspace has recently been completed by Galland Mercantile Laundry Co., San Francisco, Calif. The new 5,000-sq.ft. boiler and the 350-kw. turbo-generator set within a 28x28-ft. floorspace is a feature of the installation.

The Combustion multi-circulation, 4-drum, bent-tube, gas-fired boiler has a 200-deg. Elesco superheater. It has operated satisfactorily at 170% of rating throughout working days. Burners are inset from the upper part of the back wall to save space, being located under the drums. This improves the design, permitting the front wall to be built without breaks. It also improves combustion, because firing takes place toward the large radiant surface of the backwall, and gives low draft loss, with better mixing and air distribution.

The Byrne combustion control assures positive op-



The Byrne combustion control, operating in conjunction with gas-fired burners, maintains high combustion efficiency

eration by controlling both the fuel valve and stack damper with a cam motion produced by a system of rigid linkages motivated by a conventional hydraulic driver. A super-sensitive pilot valve causes firing rate to follow load closely. Coen Co. also supplied the mechanical-register burners, normally gas-fired, but having oil atomizers for standby.

Space saving is also a motive behind the 3,600-r.p.m. turbine driving an alternator and d.c. generator on the same shaft through a helical herringbone speed reducer which lowers driven-end speed to 1,200 r.p.m. The 350-kw. Elliott turbine is non-condensing, taking steam at 150 lb. and 200 deg. superheat. The alternator is rated 150 kw., 80% p.f., 187.5 kva., 240 volts, 3 phase, 60 cycles. The d.c. generator is rated 200 kw., 250 volts.

Of the boiler output, about 9,000 lb. per hr. flows through the turbine. Exhaust steam, at about 1 lb. gage, is used for water heating. Remaining steam from the boiler is taken through a reducing valve, desuperheated by water spray, and used for process and in bringing wash-house water up to temperature.

No steam is exhausted to atmosphere. Hot water is stored in a 40,000-gal. tank, and condensate from water heaters is returned to boiler feedwater. The tank serves two purposes: it maintains a constant supply of water for laundry demand, and it provides energy storage, compensating for fluctuations between heat and electrical demands of the plant.

Boiler feedwater amounts to 225,000 lb. per day. Weekly electrical demands of the plant total 10,000 kw.-hr. of d.c., and 5,000 kw.-hr. of a.c.

Since the plant is in balance when operating at full load, night boiler operation would create an excess of hot water, besides resulting in low efficiency through generation at fractional load. For these reasons, a 120-hp. Fairbanks-Morse diesel set was installed to carry the night load of lighting, elevators, and pumping from the laundry's own fresh-water wells. This adds another 2,000 kw.-hr. weekly to the plant's consumption of energy.

Old equipment in the plant, including two generator sets served by a 4,000-sq.ft. boiler, was left intact, constituting a complete standby system operated once a week.

F. B. Abenheim, vice-president and general manager, is unable to state economies of the new installation in dollars and cents because increases in the volume of laundry handled occurred as the new equipment was placed in operation. But he is definite about the advantages he has gained through modernization. In the first place, the increased power allows his plant easily to handle an unprecedented volume of new business, and surplus power has insured constant availability of hot water for rinsing.

Galland laundry owns much of the linen it handles. Water below 140 deg. fails to wash soap out of the cloth, which results in increased wear. On an investment of $200,000 in linen, for example, a 3% reduction in wear would represent an annual saving of $6,000. Additional benefits have been trouble-free service, elimination of standby electrical service charge, and new low cost of power generation.

Estimating Turbine Performance

By Norris D. Gove

Design Engineer, Westinghouse Elec. & Mfg. Co.

ONE of the most useful accomplishments of an engineer is the ability to make quick estimates of his problems so he can discard with minimum labor less favorable aspects and narrow the subject down to the final point of attack. Such estimates need not be of high accuracy, providing the relationship between them shows the correct trend. In the large turbine field many engineers suffer an interval of several years between turbine studies which usually means that when a new problem comes up the old studies are of reduced value. This is attested by the many inquiries made to manufacturers for performance over a wide range of steam conditions and ratings. The volume, indeed, is so great that manufacturers have been forced to develop estimating curves and formulas to promote their rapid handling. Some of the data that I use regularly in preliminary work may be of value to others. It should be borne in mind that this information is quite general and is not based on the special designs of any particular manufacturer. In making a final quotation, the builder must, of course, base his calculations on his own specific design and frame, which may result in better or poorer guarantees.

Subject to the general conditions just given and within the limits stated later, the Rankine cycle efficiency of a condensing turbine operating on the straight condensing cycle at normal rating is given by the formula:

$$E = \left(\frac{P}{1.239P + 430}\right)^{(1.0226-0.0000566\,p_1)} \times \left(1.1155 - \frac{78}{Ts + 425}\right) \left(1.0266 - \frac{0.03111}{p_2 - 0.333}\right)$$

Where

E = Over-all Rankine-cycle efficiency ratio
P = Normal rating, kw.
p_1 = Throttle pressure, lb. per sq. in. gage
T_s = Throttle superheat, deg. F.
p_2 = Absolute backpressure, in. Hg.

Example: Find the efficiency of a 20,000-kw. turbine operating under steam conditions of 650 lb. per sq. in., 328 deg. superheat (825 deg. total temperature), 29 in. vacuum. By substituting these values in the formula, the equation becomes:

$E = 0.793 \times 0.986 \times 1.012 \times 0.98 = 0.775$

By referring to the steam charts, heat available from adiabatic expansion is found to be 540.2 B.t.u. per lb., and full-load steam rate is then:

$$\text{Steam rate} = \frac{3412}{540.2 \times 0.775} = 8.15 \text{ lb. per kw.-hr.}$$

Few modern turbines are operated on the straight condensing cycle. Obtaining the efficiency by the above method is a necessary preliminary to the determination of the turbine heat rate by the following approximate formula:

$$\text{Heat rate} = \frac{9571}{E} \times F(p_1) \times F(T_s) \times F(p_2)$$

$E.$ = Over-all Rankine-cycle efficiency ratio (as above)
$F(p_1)$ = Factor for throttle pressure
$F(T_s)$ = Factor for throttle superheat
$F(p_2)$ = Factor for absolute backpressure

Values of $F(p_2)$, $F(T_s)$, and $F(p_2)$ are read from the curves below.

Example: Find the full-load heat rate with 4-stage feed heating for the conditions of the previous example.

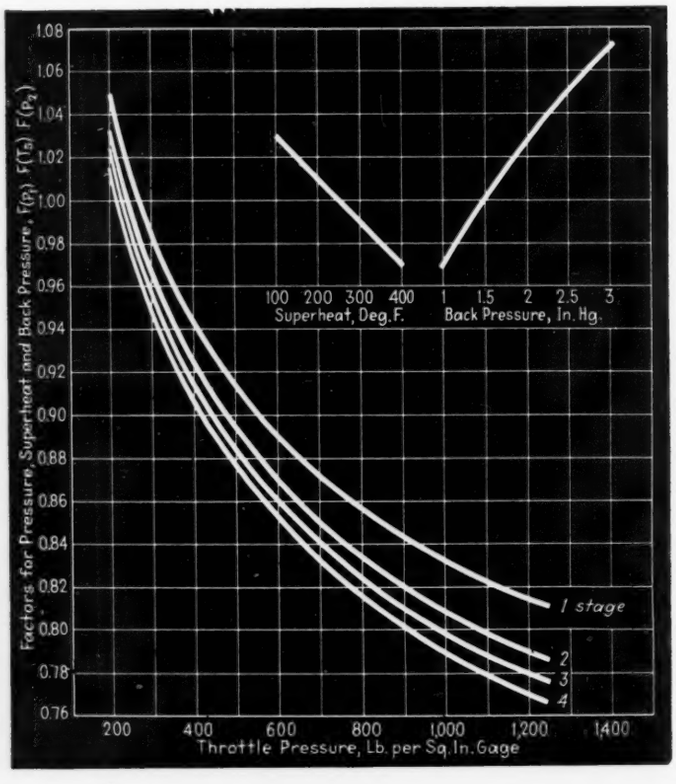
$$\text{Heat rate} = \frac{9,571}{0.775} \times 0.842 \times 0.985 \times 0.97 = 9,933 \text{ B.t.u. per kw.-hr.}$$

Empirical formulas such as these should be used with the understanding that they are only approximately correct and that, within certain limits. I use them within the following limits:

Rating .....10,000 to 60,000 kw.
Pressure .....300 to 1,250 lb. per sq. in. gage
Superheat ..... 100 to 400 deg.
Backpressure ...1 to 3 in. Hg.

The formulas seem to be a little optimistic at times for pressures below 300 lb., and when working in this range, it might be well to include a safety factor of 1 to 1½% at 200 lb., scaling this down to zero at 300 lb. With this amendment, the ordinary working range ought to be fairly well covered.

These formulas are accurate enough for all preliminary study, especially when one considers the large influence of capital costs on the cost of power at the customer's meter. For instance, a 2% error in a heat rate estimate means less than 1% on the total cost of power. These formulas should be particularly useful for comparative work such as determining whether to use 400 or 600 lb. throttle pressure, 700 or 825 deg. initial temperature, 28.5 or 29 in. vacuum.



How to Treat Gas Cylinders

DO NOT permit compressed-gas cylinders to strike each other or to drop violently. In portable service, they should be conveyed by a suitable truck or fastened securely into a safe cradle or platform, not handled by magnet, or rope or chain sling. Keep them far enough away from actual operations so that sparks, hot slag or flame cannot reach them.

If cylinders are used on scaffolds or temporary stages, fasten them securely so that they cannot fall or trip employees moving about them. When operations are conducted in cramped or confined quarters, always place the cylinders a reasonable distance away. Extra hose makes this readily possible. In such cases, station someone near the cylinders to shut off the valves if an emergency arises.

Sufficient emphasis can hardly be given the rule that oxygen and acetylene must never be transferred from one container to another; neither should other gases, chemicals or compressed air be placed in cylinders intended for other specific gas service.

Beware of the violent reaction of high-pressure oxygen with oils and greases. Never permit the handling of cylinders or apparatus with oily hands or gloves nor allow oil or grease directly or oily waste or rags to come in contact with oxygen cylinders, valves, regulators, gages or other fittings.

Gas cylinders should be stored inside suitable ventilated buildings, away from radiators or other heat sources, also protected from moisture and accumulations of ice or snow. Oxygen is not a flammable gas, but is a supporter of combustion. Therefore, such cylinders should not be stored near inflammable material, especially oil, grease or other substance likely to cause or accelerate a fire. Again, be sure the cylinders cannot fall or be struck by falling or passing objects. Store and use acetylene cylinders with the valve end up.

Don't carry excessive stocks of cylinders in reserve; order as you need them. This avoids difficulties in locating long-lost cylinders. Mark empty cylinders plainly with chalk, not with oily crayon, and keep empties separate from full ones so actual stock can be readily determined. Storekeepers should not release a full cylinder except on return of the empty. Inspect reserve cylinders regularly. Return defective or damaged cylinders at once.

These are merely abstracts of the rules for proper care, taken from a talk by F. R. Fetherston before the International Acetylene Assn. Complete rules can be obtained free from the Compressed Gas Mfrs. Assn., 11 West 42nd St., New York, N. Y.

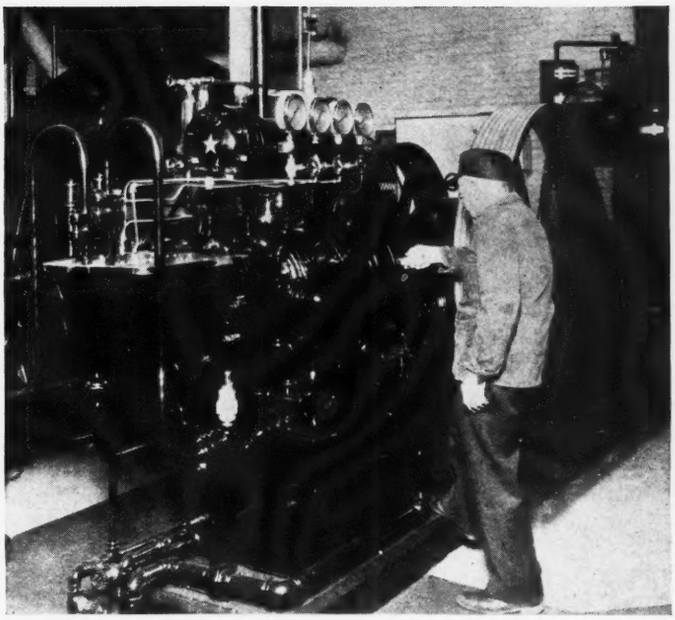


Fig. 1—(Rochester Camera Exchange Photo). The old 3,500-lb. pressure, 3-stage compressor

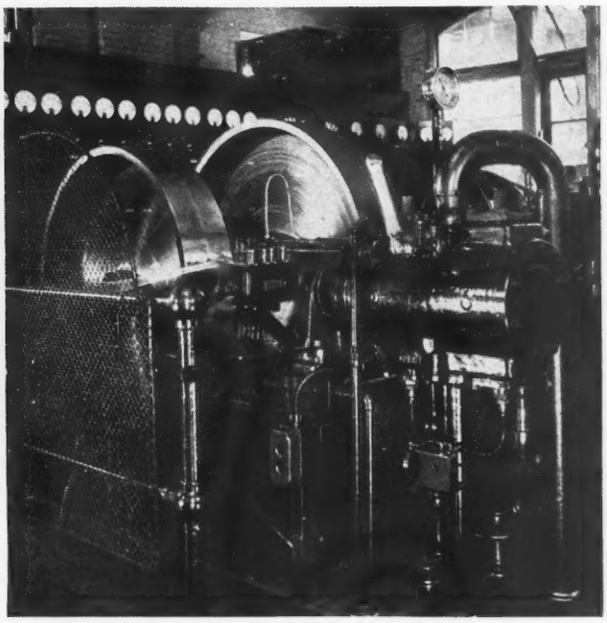


Fig. 2—(Power Photo). New head and motor and higher speed convert old machine to 175 c.f.m. and 100-lb. pressure. Total cost $475

Young Head on Old Shoulders

FOR testing instruments, making thermometers, etc., air pressures up to 3,500 lb. per sq.in. were required in the works of the Taylor Instrument Companies, Rochester, N. Y. Until recently this was supplied by the compressor shown in Fig. 1—a single-crank machine with trunk piston stepped for four stages of compression. Drive was by motor, Vee-belted.

With the demand for still higher pressure, larger capacity and better efficiency, a new synchronous motor-driven, tandem, multi-stage compressor for 4,000-lb. pressure was installed. To salvage the investment in the old compressor, a new single-stage cylinder head for 100-lb. pressure was substituted for the 4-stage cylinder head. The 25-hp. motor was replaced by one of 40 hp., and the machine speeded up from 150 r.p.m. to 300. This could be done without danger because the frame, shaft, crank, etc., had originally been designed for that speed.

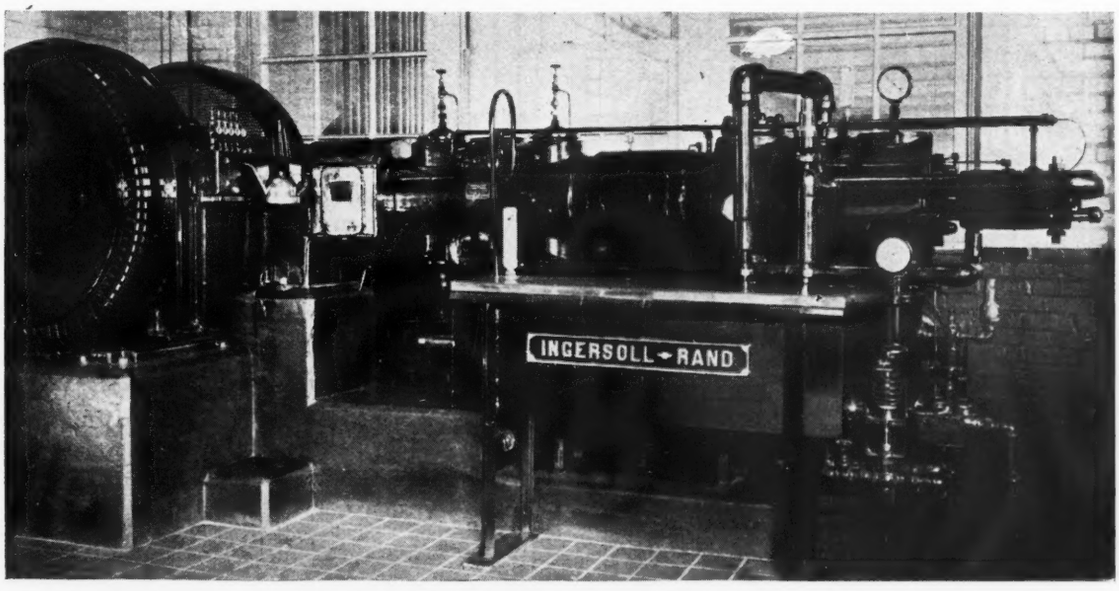
Allowing for the salvage value of the old motor, the total cost of obtaining a 175-c.f.m. compressor (with drive), as shown in Fig. 2, was $475.

The revamped machine takes some of the 100-lb. air load formerly carried by steam-driven compressors, thus reducing the summer waste of exhaust steam. All work was done by the plant crew.

Fig. 3 shows the new high-pressure unit rated to compress 105 c.f.m. of free air to 4,000-lb. pressure. Drive is 75-hp. flywheel-type synchronous motor, built in.

The story of these changes was given to a visiting *Power* editor by Wm. Gessner, chief engineer of the Taylor power plant.

Fig. 3—New synchronous motor-driven compressor for 105 c.f.m. free air at 4,000-lb. pressure



German Experiences with Load and Level Feed Regulation

Curves plotted at the Hirschfelde power-plant in Germany show actual operation of mechanically coupled feed regulators governed by water level and boiler load

By D. W. Rudorff
Dipl. Engr., A.I.E.E., V.D.I.

REPLACING three old boilers showing symptoms of caustic embrittlement, a new boiler was recently installed in the Hirschfelde Power Plant in Germany.[1] One of the conditions imposed upon the boiler maker was that a maximum steam output should be obtained with the new unit within the space occupied by one of the old 8,050-sq.ft. boilers delivering 48,400 lb. of steam per hr. Furthermore, the new boiler was to be equipped for unit mill firing of lignite of 3,703 B.t.u. per lb. in lower heating value, and of about 48% moisture and 14.3% ash content.

The boiler decided upon is, as Fig. 1 shows, a 2-drum, bent-tube unit set over a completely water-cooled furnace, equipped for tangential firing and of a design representing a German variety of the Wood Steam Generator furnace. Most important operating data of the boiler are:

Actual evaporation, lb. per hr.....	88,000	156,200	220,000
Boiler pressure, lb. per sq. in....	227	227	227
Steam temp. at superheater outlet, deg. F.....	673	720	774
Feed water enter. boiler proper, deg. F.....	324	360	388
Flue gas temp. at boiler uptake, deg. F.....	252	324	388
CO_2 at boiler uptake, %.....	14.5	15.0	15.0

[1] Owned by the A G. Saechsische Werke, Dresden.

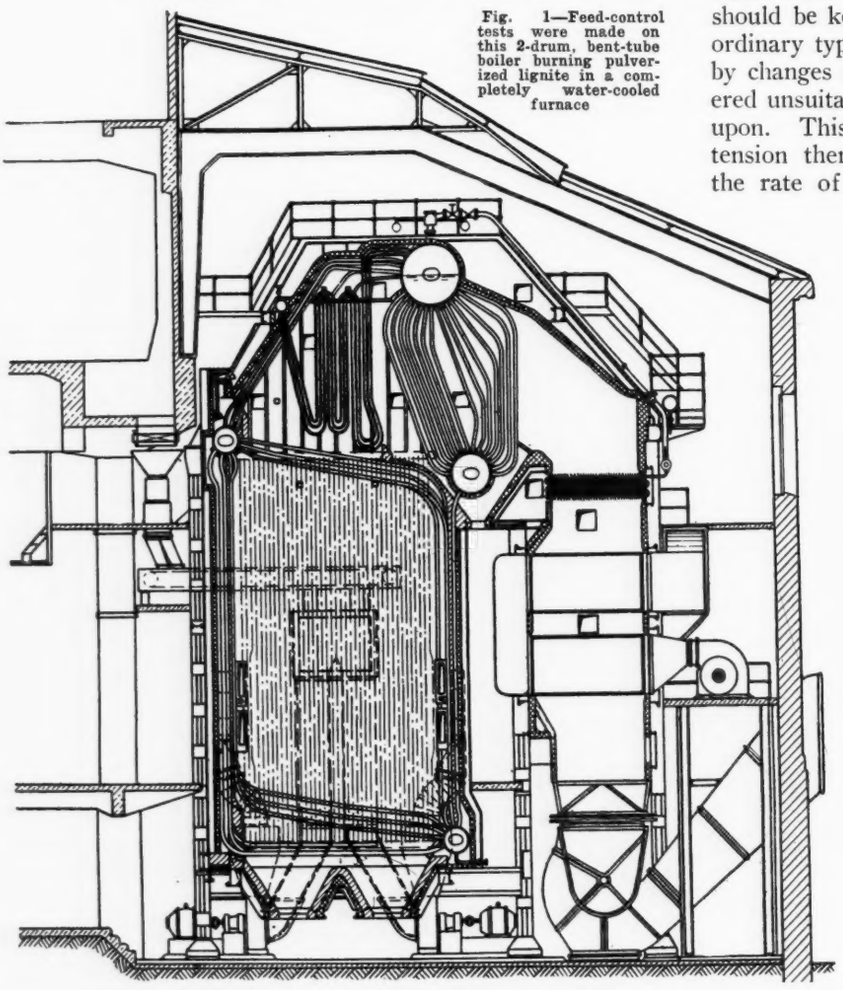


Fig. 1—Feed-control tests were made on this 2-drum, bent-tube boiler burning pulverized lignite in a completely water-cooled furnace

Predrying of the coal is effected by supplying the mills with a mixture of preheated air and of flue gas of high temperature (abt. 1,750 deg. F.) taken from the furnace. Naturally, the reduction in moisture content of the coal depends on the amount of flue gas passed through the mill at varying loads. Motor-controlled dampers are provided in the air and flue-gas supply ducts so that the optimum ratio of air and flue gas at the mill can be easily established at any load level.

Special attention was paid to the problem of feedwater regulation, and it was specified that a practically constant water level should be maintained in the boiler at all loads and that fluctuations of the water level in the case of sudden load fluctuations should be kept to a minimum. For this reason, the ordinary type of feedwater regulator actuated solely by changes in water level in the drum, was considered unsuitable, and a Copes double control[2] decided upon. This consists of two mechanically coupled tension thermostats, of which one is actuated by the rate of steam flow and the other by changes in boiler-water level. As Fig. 2 shows, one such regulator set is placed in each of the two feed lines.

The steam ends of the steam flow thermostats A and A_1, shown in Fig. 2, are connected to pitot nozzles in the steam headers, the nozzles facing into the steam flow so that the pressure in this thermostat connection is the sum of static and dynamic pressure. The lower thermostat connection is made to a reservoir connected to the steam header at the level of the upper end of the thermostat and is therefore subjected to the static steam pressure.

Steam condensing in the thermostat fills the water connection and the condensate reservoir. If no steam flow takes place, the thermostat is then filled with water. As steam flow

[2] Made and supplied by Messrs. Feurungsanlagen, A. G. Heidelberg.

in the main steam header builds up, the resulting dynamic pressure forces the water level in the thermostat tube down to a point at which equilibrium is restored. Thus steam enters the thermostat and expands its tube. Vice versa, when the steam flow decreases, the water level in the tube will rise again due to the decrease in dynamic pressure on the steam connection side. In this way, action of the steam thermostat is solely a function of steam flow and is independent of both boiler pressure and water level.

The water level thermostat is connected to the boiler drum in the usual manner, that is in the same way as a water column, so that when water level rises above the normal level for which the thermostat is set, the water in the tube will rise correspondingly and the tube will contract. When water level goes down in the drum, water level in the tube will do likewise and the steam entering will expand the tube.

The mechanical connection of the free ends of the thermostat tubes of the two thermostats is made, as can be seen from Fig. 2, by a steel tape led from the free end of one thermostat tube over a block attached to the link-and-lever system of the feed-water valve and back to the free end of the other thermostat tube. In this way the actions of both thermostats are superimposed. If their movements are in the same direction, as when both thermostat tubes expand (and therefore tend to open the valve) the resultant valve movement will be the sum of both impulses. On the other hand, if their actuating tendencies are opposite, that is if one thermostat actuates toward closing and the other toward opening of the valve, the resultant valve movement will be the difference of the two impulses. Likewise, if one thermostat is at rest, the movement of the other can act alone in either direction.

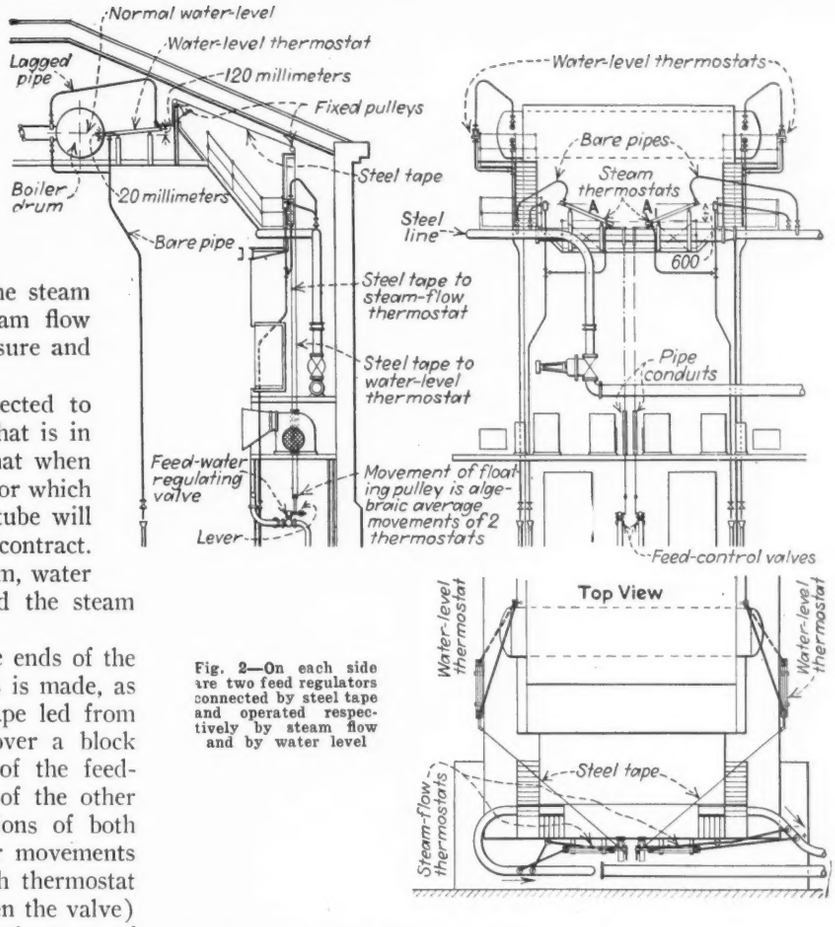


Fig. 2—On each side are two feed regulators connected by steel tape and operated respectively by steam flow and by water level

Load Increase

Thus when the load suddenly increases, the steam-flow thermostat will begin to act at once towards an increase of the feed rate. But as the water level will have suddenly risen due to the swell of the boiler water, the water-level thermostat will also go into action and move towards closing of the valve. The resultant feed rate, and with it the finally-established resultant water level (if the new rate of steam load is maintained), will therefore depend on the relative movement of both thermostats.

Thus it is easily seen that by proper adjustment of the sensitivity of the two thermostats any kind of desired combined characteristic can be obtained. Adjustment of the steam-flow thermostat is made by changing the angle of impingement of the pitot nozzle in the main steam line; for this purpose the nozzle can be rotated in its stuffing box where it passes through the steam line. The sensitivity of the water-level thermostat is adjusted by varying its slope against the horizontal.

While at Hirschfelde the regulator characteristic is adjusted for maintenance of a constant water level with changing load, it would of course also be possible to produce any other characteristic desired; it is, for instance, possible to set the regulators for the achievement of a higher water level at high load and a low water level at low load.

To ascertain whether the feedwater regulator

SUPPLEMENTARY INFORMATION RELATING TO THE HIRSCHFELDE BOILER

Boiler heating surface	5,680	sq.	ft.
Waterwall surface	3,620	"	"
Economizer surface	18,080	"	"
Air preheater surface	43,300	"	"
Superheater surface	4,900	"	"

EVAPORATION IN LB. PER HR.

% of total heat absorbed by—	88,000	154,000	220,000
1. Radiant surface	33.2	25.9	21.2
2. Convection surface	29.1	29.3	27.2
3. Superheater	10.2	11.2	10.8
4. Economizer	6 3	10 3	13 4
5. Air preheater	8.7	9.9	11.6

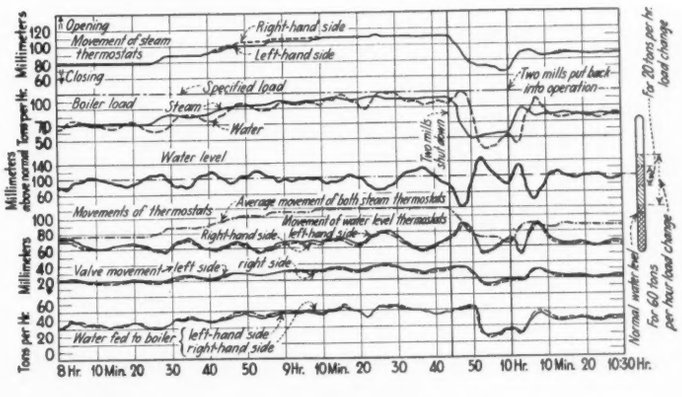


Fig. 3—Curves show what happened to thermostats, control valves, water flow and feed level when boiler load was suddenly changed

could maintain constant water level in the case of violent sudden load drops, a special test was made at Hirschfelde from which the operating characteristics reproduced in Fig. 3 are derived. As the curves of this chart show, steam load on the boiler was gradually built up to a rate of 220,000 lb. per hr. with water level remaining constant. It is interesting to note that maintenance of the constant water level was mainly due to the action of the steam-flow thermostat.

At a given moment, two of the three mills in operation were suddenly tripped so that a sudden fall in steam output to 110,000 lb. per hr. took place. The curve of the movement of the steam thermostat shows its almost instantaneous response by acting towards closing of the feed valve. At the same time the water-level thermostat began to act towards opening the feed valve since it had come under the influence of the sudden drop in water level caused by the shrinkage of the steam bubbles. The valve-position curve shows that these counteracting tendencies of the thermostats resulted in an unchanged position of the feed valve during the first 4 min. after the load drop. After this, however, followed a swing-back of the water level to its original elevation, so that the water-level thermostat also began to operate towards closing of the valve. About 8 min. after the load drop, feed rate had settled at its new level.

The chart also shows that when the mills were restored to operation, the feed rate corresponding to a new load level of 176,000 lb. per hr. was established within a minimum of time and with a but slight and unavoidable minor fluctuation of the water level.

The result of this test therefore affords convincing proof that a combination regulator of this type is able to maintain constant water level under even the most difficult operating conditions. It may be added that equally good results were obtained in other large German plants in which the action of regulators of the same type is adjusted to the maintenance of high water level at high load and a low one at low load.

What Type for Chief?

By Harry M. Spring

Flushing, N. Y.

THE modern power plant places the responsibilities of operations, tests, maintenance, costs, hiring, etc., on the shoulders of the chief engineer. Hence, the term "chief engineer" as used here does *not* mean, as in some of the older plants, a man who is merely the "boss of the firing gang"—often nothing more than a skilled laborer of moderate intelligence.

Desirable qualifications are grouped into six divisions. Study and consideration of these should be of value to the employer in choosing his man. Also, the engineer prospect may study these groups and find the points where he is weak, then take steps for self-improvement.

Past Record

The plant owner who employs a chief engineer without closely examining the man's past record, places himself in the same category as the kind-hearted tourist who "picks up" a hitch-hiker for a chauffeur and then takes a nap. Anything may happen, from minor accidents to disaster. When a man is chosen to take charge of a multitude of responsibilities, it is imperative that he have the necessary qualifications. These are not reflected by repeated failures in similar jobs.

Correct analysis of references is of importance. One man applied for an opening as chief engineer recently and was turned down because one former plant owner answered inquiries by saying the man was discharged because of incompetence. This man, although unusually capable, was not given further consideration, notwithstanding excellent references from all other employers. A little further investigation would have shown that the executive who gave the poor recommendation had not discharged the chief engineer because of incompetence but because the chief would not agree to a plan to aid this executive and several others in entering false purchase and contract records for graft.

Turning to the other extreme, a chief engineer was hired to take charge of a Pennsylvania power plant. He was chosen on the strength of excellent reference letters. Within six months, costs of operation and maintenance jumped nearly 50%. A few contributing factors included repairs due to low water in one boiler, poor combustion due to neglected instruments and limited knowledge in this field, and a burned out feed-pump bearing due to neglected oil changes. Further investigation showed the reference letters were forgeries.

Practical Ability

It is inconceivable to consider a man who has not been "through the mill" for a position as chief. No engineering position in a modern power plant can be filled with a more valuable man than one who has started at the bottom and worked to the top through his own ability, ambition, experience, and learning. Breaking in a new operating engineer, training a new fireman, instructing a repair crew, all depend on just what practical experience this man in charge has had. If he can show his men how, as well as tell them, results are far more satisfactory.

A valuable measure of the engineer's ability is set up by the departments of public safety in many states and cities. A license examination of the man's experience and knowledge must be passed before he is allowed to take charge of a plant.

Wide practical experience of a chief engineer brings profitable returns to the plant owner. Operating conditions leading to breakdowns and accidents are foreseen, and accidents are prevented. When unexpected trouble does occur, the well-trained chief can supervise proper repairs in the shortest time and by the least expensive method. This often eliminates the necessity of calling in high-priced "experts."

A more serious example of a chief engineer who lacked knowledge of practical training occurred in a wood products mill. A fire-tube boiler, small compared to boilers used for power generation, and its low operating cost made it appear unimportant to an untrained chief engineer. Neglect caused an explosion which killed two people, injured seven, and demolished a large part of the mill.

Technical Knowledge

An editorial in *Power* very aptly stated that technical ability is the headlight that lights the way, while practical ability is the power that pulls the train. Actually, the modern power plant presents a far different proposition than the plant of twenty, fifteen, or even ten years ago.

One can well remember, and still see some neglected, obsolete plants—a dark, dirty, clutter of poorly kept boilers and machinery. The usual qualifications for a chief engineer were that the man have a strong back, a voice like a bull, and should not necessarily be too bright. He should be able to make mechanical repairs, but should not engage in activities towards improvements in operating practice, or anything so radical as suggesting plans for a change in plant design. If a new type of feedwater heater would improve operation, the company treasurer would decide on the advisability of purchase. Need of a new steam trap would be referred to a department manager. Decision on the type of coal to purchase would be made by the purchasing agent, and possible returns from an investment in a new boiler and turbine were just not to be spoken of; at least, certainly not by a mere chief engineer.

The chief engineer of a pulp mill in the Northeast came to the president of the mill some months ago and brought up the question of installing a water softener. The conversation went something like this:

"But we need that softener, sir. We have to shut a boiler down for a week every six months to remove scale."

Mr. Blank, the president, replied: "Well, remove the scale then, that's what you're paid for. And furthermore, when water is good enough to drink, it should be good enough for your boilers. We have used it for ten years, and the boilers are still good."

"But we could save money—"

"Spend money, you mean. Fifteen hundred dollars for something to save you a little work is all you're thinking of." And so the conversation ended.

The engineer who lacks technical knowledge would immediately condemn the company executive. He would say the engineer deserved sympathy, that he just wasn't given a chance to improve things. Actually, the so-called chief should be condemned. He had no ability to present facts.

Had the company president been confronted with figures showing the savings in fuel that would result from clean boilers, the dollars and cents that were going up the stack in lost heat units in one year, and had he been presented with a summation of ten years' loss compared with cost of installing and operating a water softener, he would have been much more interested.

A technical man is often, but not necessary, a college graduate. He is a man who has the ability to grasp technical problems encountered in every branch of power-plant engineering. He should be trained by college, outside courses, or extensive reading and study to grasp and analyze the factors of power-plant operation, design, construction, and maintenance. The man in charge of a power plant should keep neat records of costs, operating log data, etc., and should keep plant efficiency up and costs down.

The modern power plant, with its maze of push-buttons and meters, is still far from foolproof. Most installations are intelligently designed. To secure safe and efficient results, they must be intelligently operated and supervised. Technical-minded men are essential.

Initiative

The man who is satisfied as long as things run as well as usual, and who cannot think of making a change towards improvement under such conditions, is usually lazy. He may escape this category, and just not be broad enough to grasp a situation open for improvement, at any rate, he has no place in a supervisory position.

Psychology is a factor of the prospective engineer that may well be considered. Many excellently trained men are unsuccessful as chief engineers because of inferiority complexes. Many hesitate to make even minor changes or improvements for fear of being censured by the plant owner. While, from the owner's point of view, it is undesirable to give a free hand to a new man in all unapproved purchases and business activities, it is certainly a nuisance to have a chief engineer running in for permission to order new gage glasses, to pack a pump, or to have an instrument calibrated.

Breadth of Vision

The proper choice for a supervising engineer of the power plant should consider the broadness of engineering outlook. Power-plant engineering is moving ahead at a rapid pace. New methods are being discovered while old ones are discarded as uneconomical. The man must keep up-to-date with new developments and methods so as to effect all possible savings. There are unlimited opportunities for this in subscribing to and taking interest in the best engineering publications.

PRESSURE-TYPE FILTERS for Lubricating Oil

By James I. Clower

Assistant Professor of Machine Design, Virginia Polytechnic Institute

Recent years have seen extensive application of these units on steam and internal-combustion engines, air and refrigerating compressors, gear drives, etc. Here several types are described

PRESSURE- and vacuum-type filters have become quite common with the introduction of pressure-feed lubrication systems, and are adapted to steam engines, air and refrigerating compressors, machine tools, internal-combustion engines, gear drives, etc. Pressure and vacuum filters are identical in design, the difference being in the relative positions of filter and oil circulating pump. If the filter is placed in the pump discharge line, hence subject to a positive pressure, it is a pressure type. On the other hand, if the filter is in the pump suction line, it is termed a vacuum filter.

Cloth-Type Filters

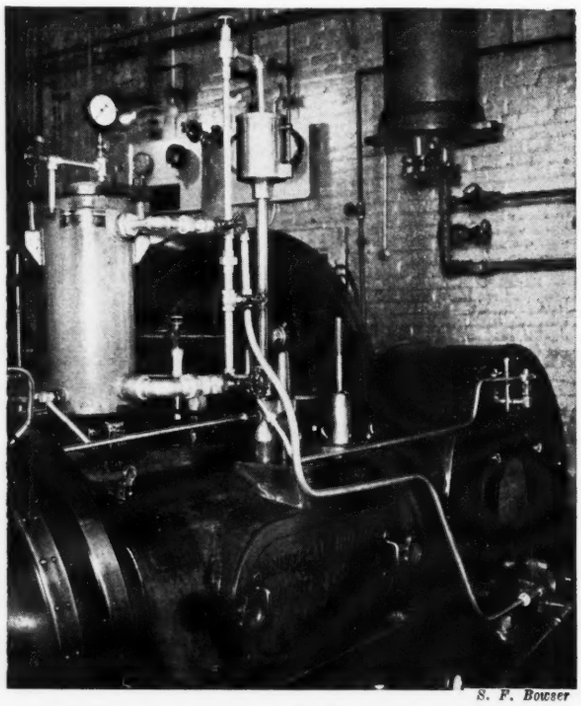
Figs. 1 and 2 show two designs of pressure filters using cloth or fabric as the filtering medium. In Fig. 1, the filtering element comprises four fabric bags, with flexible-link metal matting separators between them rolled up to fit into a cylindrical container. Oil enters the filter at the bottom under pump pressure and is forced along the path indicated by the arrows. As a precaution, a spring-loaded relief valve bypasses oil to the bearings should the filtering element become clogged with sludge. This filter is designed for a working pressure as high as 100 lb. per sq.in., and is available in capacities of 65 to 720 gal. per hr., based on an oil having a Saybolt viscosity of 182 sec. Filtering-element area varies from 2 to 21 sq.ft., depending on capacity. Filtering elements are wool, linen, or cotton. Wool is generally recommended for use when the oil has a high sulphur content, while linen or cotton is used where a high degree of filtration is required, such as on large gears lubricated with a highly viscous oil.

In the filter, Fig. 2, oil is forced through its filtering element in the direction of the arrows, leaving the deposit of sludge on outside surfaces. The sludge deposit acts as an additional filter bed, increasing effectiveness as deposit thickness increases. However, resistance to flow through the filter also increases. It is therefore necessary to wash the element periodically depending on the amount of impurities in the oil. In this filter, large filtering area is obtained by winding the fabric over two helical springs of different diameters, giving the appearance of a deep-root thread.

Figs. 3 and 5 are two metal-element pressure filters. In Fig. 3, the filtering element is constructed by winding a ribbon of bronze, monel metal, stainless steel, brass, or other metals edgewise to form a cylinder, which is placed over a corrugated frame. The ribbon has a flat front edge and tapers in cross-section, Fig. 4, thereby providing a wedge-shaped oil passage to prevent clogging behind the front edges. At regular intervals, projections of uniform height support the ribbon radially to the frame on which it is supported. Projection height, which varies from 0.015 to 0.0005 in., determines the degree of filtration. Oil flow is in the direction indicated by the arrows.

Two designs of knife cleaning mechanisms are used on the filter, Fig. 3. In one, the knife is rotated by a handle while the filtering elements remains stationary. In the other, the knife remains stationary while the filtering element is rotated.

The filter of Fig. 3 is obtainable in single-, double- and triple-element types, as well as in single- double- and triple-stage types. In multi-element types, the filtering elements are arranged in parallel and flow from each element into a common discharge header. In the multi-stage type, elements are in series and oil passes successively through each. This



S. F. Bowser

Pressure-type filter connected into a steam-engine lubrication system to purify bearing oil continuously

filter is obtainable in capacities from 11.2 to 153 gal. per min., based on kerosene at 80 deg. F. and 15 lb. per sq.in. pressure. Capacities, of course, vary with pressure, oil viscosity, and size of slots.

Essentially, the filter of Fig. 5 consists of a stack of round, thin, perforated disks, each separated from its neighbors by thin metal spacers, spacer thickness determining the degree of filtration. Oil enters the filtering element from the outside, passes through the small spaces or slots between disks, flows up through the center and passes out through the outlet pipe. Any solids larger than the thickness of the spaces between disks are prevented from passing through the filter, and are held against the outside surfaces of the element.

The layer of sludge accumulated on the outside surfaces of the filtering element acts as an additional filter bed and improves filter effectiveness. This accumulation, however, increases the resistance and makes necessary its removal, accomplished by a built-in cleaning device, Fig. 6. It consists of a fixed rod to which is attached a series of cleaning blades, one of which extends into the space between each pair of disks as far as the inner edge of the rim. When the central spindle carrying the disks is rotated, the cleaning blades scrape off the layer of sludge on the element and comb out any dirt that may have lodged between disks. One complete revolution of the element is required for a cleaning operation. Sludge thus removed sinks to the sump below the element, whence it is removed through the drain hole. Where continuous cleaning is desired, the filtering element is rotated cotinuously by means of an electric motor and the sump is provided with a shut-off valve so that it can be cleaned while the filter is operating.

This filter is obtainable in single-, double- and 4-element types varying in capacities from 5 to 900 gal. per min., based on oil having a Saybolt viscosity of 300 sec., spacing between disks of 0.006 in., and a pressure drop across the filter of 5 to 10 lb. per sq. in. Internal parts may be obtained made of various materials in order to meet specific operating conditions. Materials frequently used are bronze, mild steel, stainless steel; for extremely corrosive conditions, chrome-plated steel disks, cleanings, rods, etc. are used.

Fig. 7 is a section through a pressure-type filter that may have six to nine filtering elements or plates, depending upon capacity required. These filtering plates may be cloth bags over a coarse-mesh galvanized-iron wire screen or they may be two pieces of fine Monel-metal gauze with a coarse-mesh-screen inserted between them and the assembly bound around the edges with a sturdy frame, Fig. 8. The coarse-mesh screen is used to prevent filtering surfaces from touching under pressure, thereby assuring an open channel through which the oil can flow. The choice of filtering material depends on service. For most bearing oils the cloth element meets the requirements, while Monel-metal is used for heavier, more viscous oils.

This filter is available in four sizes, varying in capacity from 5 to 200 gal. per min. and having filtering areas from 4.5 to 38 sq. ft. It is capable of withstanding a working pressure as high as 50 lb. per sq.in. Elements should be removed and cleaned

Fig. 1—Large area is secured in this filter by using four bags with spacers between them rolled up to fit into a cylindrical container

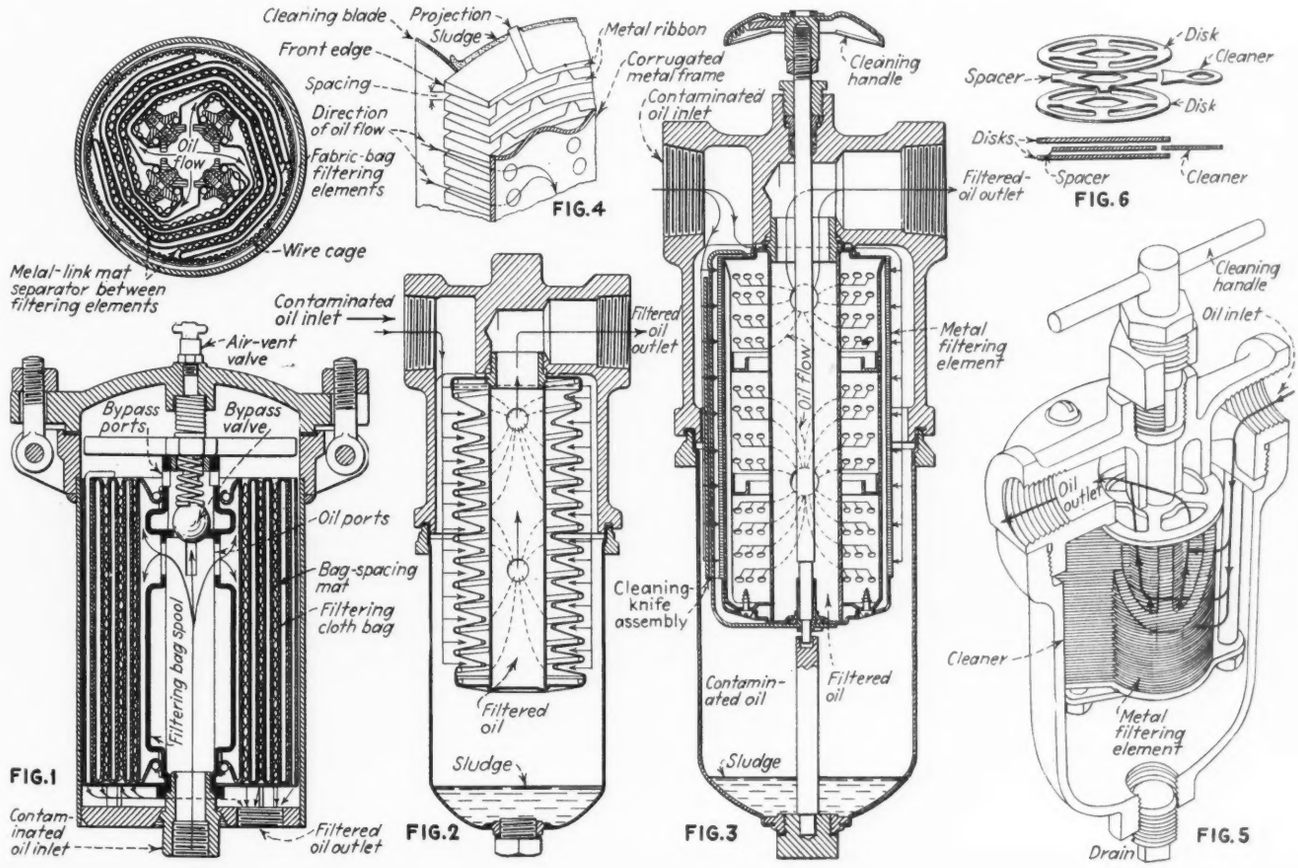
Fig. 2—An extended area is obtained in this filter by winding the fabric filtering medium over two spiral springs of different diameters

Fig. 3—Cross-section of a filter in which the filtering medium is a closely spaced metal ribbon wound on edge to form a cylinder

Fig. 4—Enlarged section of metal-ribbon filtering medium, Fig. 3

Fig. 5—Filtering element in this type consists of a stack of closely spaced, perforated metal disks

Fig. 6—Shows how filtering disks and cleaning elements are arranged in the filter, Fig. 5



when a differential of 12 lb. exists between the inlet and outlet pressures.

The photograph shows one of these filters applied to a steam engine. Its intake connects to the engine oil pump and its discharge to the engine lubrication system, so that the oil is continuously purified. Suitable valves and bypasses allow the filter to be removed for cleaning without interfering with engine operation.

A pressure-type filter primarily designed for diesel engines of 100-hp. capacity or less is shown in Fig. 9. It is also adaptable to other internal-combustion engines having a displacement of 600 cu.in. or more. Another filter of the same general design but of smaller capacity is built for the latter engines, of less than 600 cu.in. displacement. Filters connected in parallel will handle diesels above 100-hp. rating.

The filtering element or cartridge is a molded cylindrical block of hard-baked Fuller's earth, on the outside of which is wrapped several layers of cellulose held securely by garter springs. Contaminated oil enters the housing near the top and flows radially through the filtering cartridge and the Monel-metal screen surrounding the hollow center positioning rod. Small radial holes are drilled in the positioning rod through which oil flows to the outlet at the center of the bottom cover. This filter is said to remove all solid impurities as well as all asphaltines, carbonaceous materials, and other constituents having acid- and sludge-forming characteristics.

The pressure-type filter, Fig. 10, is designed for internal-combustion engines in capacities of 2 to 200 gal. per hr. Its filtering elements are hundreds of paper disks or washers about 1.5 in. in diameter and especially treated to resist deterioration, stacked or assembled around a tube, with a helical spring which presses them together with a force of 80 lb. Oil under 30-lb. pressure enters the housing near the bottom, completely submerging the filtering elements, through which it flows in a radial direction to their centers and thence upward to a manifold at the top. From the manifold the oil returns through the 3-way valve to either the machine oiling system or to a purified-oil tank, depending on whether the filter is used with a bypass or batch system of purification.

This filter employs what is commonly termed edge filtration. It is claimed that the maximum width of the spaces between the disks is less than 0.00004 in., thereby providing an exceedingly fine screen. In some designs an electrically driven rotary pump or an air-pressure type receiving tank may be provided for delivering the oil to the filter at a pressure of not more than 30 lb., while in the design of Fig. 10 an inlet orifice controls oil pressure.

In all designs, filtering elements are cleaned by compressed air. After the filter is drained, a compressed-air hose is attached to the 3-way valve at the outlet and air is blown through the elements in the opposite direction to that of oil flow. Thus any sludge that may have collected on the outer surfaces is dislodged and drops to the bottom, where it is removed through the drain.

The division plate has two bypass valves, one for bypassing oil when starting in cold weather and the oil is too viscous to be pumped through the filtering elements, and the other for relieving air pressure above 40 lb. when cleaning the elements.

This filter may be obtained provided with either thermostatically controlled heating elements, a hot-water or steam-heated jacket for heating the oil to the recommended temperature of 160 deg. F. In internal-combustion engines, the hot-water jacket may be connected into the cooling-water system of the engine. Also, for internal-combustion-engine service where dilution is excessive, an electrically heated rectifier may be used.

The author is indebted to Wm. N. Nugent & Co., Chicago, Ill., Motor Improvements, Inc., Newark, N. J., Cuno Engineering Corp., Meriden, Conn., S. F. Bowser & Co., Inc., Fort Wayne, Ind., Skinner Purifiers, Inc., Detroit, Mich., and Briggs Clarifier Co., Washington, D. C.

Fig. 7—Multiple bag-type pressure filter; bags may be fabric or monel-metal gauze

Fig. 8—One of the bags used in the filter, Fig. 7

Fig. 9—In this type the filtering element is a molded cylindrical block of hard-baked Fuller's earth

Fig. 10—Filtering elements in this type comprise stacks of special paper disks held together under pressure by spiral springs

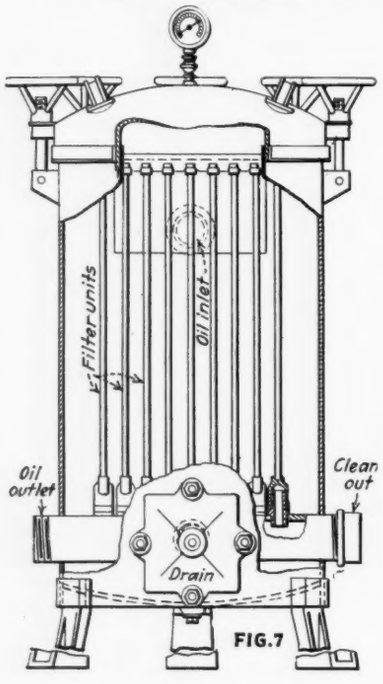


FIG.7

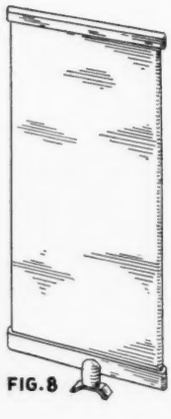


FIG.8

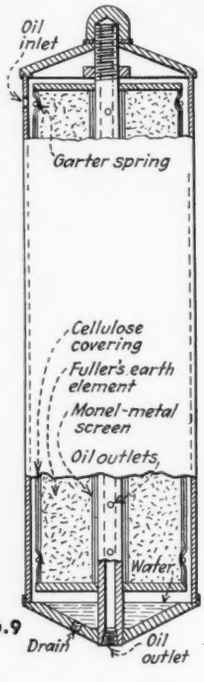


FIG.9

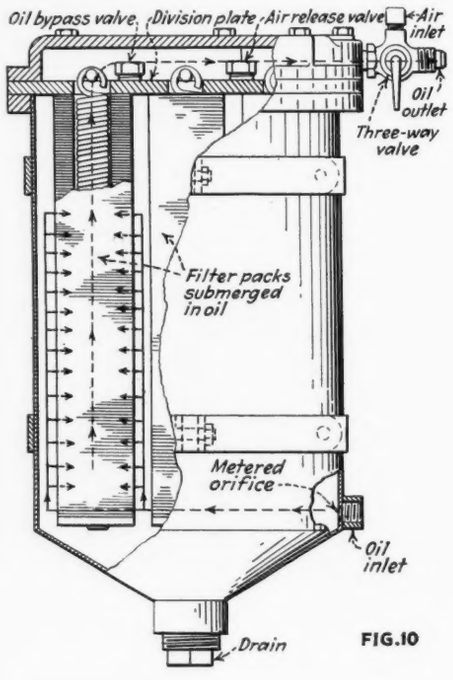


FIG.10

Check Your Own I-Beams

By B. G. Switzer

ALTHOUGH it might be thought that a knowledge of structural members would be outside the scope of an operating engineer's experience, he is nevertheless called upon to supervise dismantling of machines for inspection. This involves the use of an I-beam and block and fall for heavy parts.

Before selecting a beam for a particular purpose, it may be advisable to see what happens when a beam, resting between two supports, is loaded. Consider the beam, Fig. 1, which is divided into a number of sections of equal length. Now let us place a weight on the beam. When this is done the beam bends downward with the result that points *A′, B′, C′,* etc., come closer together while points *A, B, C,* etc., get farther apart. What does this mean? Just this: in order to support the weight on the beam, the metal in the top part of the beam is squeezed together while that on the lower part of the beam is stretched. We see then, that two forces resist or tend to prevent bending, compression on the upper part and tension on the lower part of the beam.

Stresses in structural members subjected to this type of loading, should be kept below 18,000 lb. per sq.in. As the elastic limit of structural steel is around 36,000 lb. per sq.in., the above value is well within the safety zone.

This internal stress f, often called the fiber or skin stress, is so related to the size of the beam and the weight placed on it that $f = \frac{Mc}{I}$, where $M =$ maximum moment on the beam in inch-pounds, $c =$ distance to most stressed fiber or one-half the depth of the beam, and I equals the moment of inertia in inch units, as obtained from a handbook.

Fig. 1—When a beam is loaded, its top fibres are compressed and its bottom ones stretched

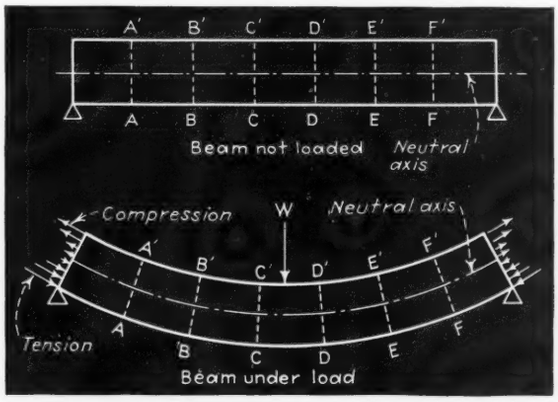
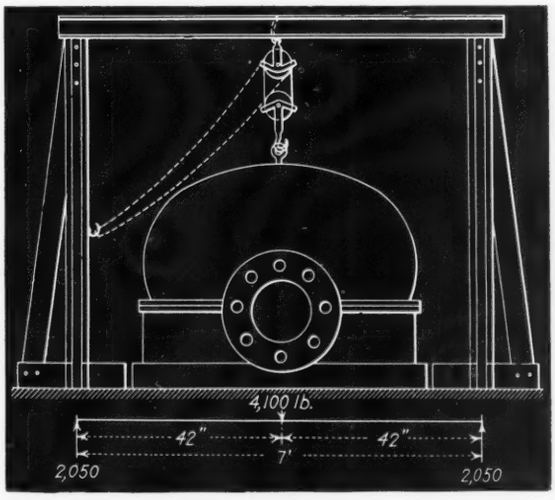


Fig. 2—A common job around the power house: lifting a turbine casing with a chain fall



With these facts in mind, let us apply them to a problem that may arise in the power house. To check the safe load on a beam, let us make use of a catalog of standard steel beams. These catalogs give the greatest bending moment that beams of various sizes will stand. Since these values are given, it is only necessary to figure the bending moment on the beam we wish to use and to compare this with the value given in the catalog.

Suppose that we have to lift the casing on a small turbine for inspection purposes. The casing, according to the manufacturer, weighs 4,100 lb., and we wish to lift it with a differential hoist from the center of an I-beam supported on either side of the turbine, Fig. 2. The closest we can get supports for the beam on either side of the turbine is 7 ft. The maximum bending moment on the beam is the sum of all the moments to the right or left of the point where load is applied, in this case the center.

Remembering that a moment is a force times a distance, and that each support carries half the load, 2,050 lb., the load being in the center of the beam, we have for the maximum bending moment 2,050 $\times$ 42 = 86,100 in.-lb. Looking this value up in the catalog, we find that a 5-in. beam having a cross-sectional area of 2.87 sq.in. will stand a maximum moment of 87,000 in.-lb. Since our value is below this, a 5-in. beam will be safe for our use. The greatest internal stress in the beam will be

$$f = \frac{Mc}{I} = \frac{86{,}100 \times 2.5}{12.1} = 17{,}850 \text{ lb. per sq.in.}$$

This value is below 18,000 so the beam is also safe as far as stress is concerned.

We may, however, wish to use a beam from the scrap pile. In this case we can measure the end dimensions of the beam, figure its cross-sectional area, look up this area in the catalog, and find the corresponding bending moment and check with the value of 86,100 in.-lb. Since we probably cannot accurately determine the cross-sectional area of the beam, the calculated area may not check with any one given in the steel catalog. Under these conditions, select from the catalog the next smaller size. If this beam will carry the load, then the one we picked from the scrap pile will be safe.

A few minutes spent in checking up on beam loadings may be well worth while, especially where expensive machinery is involved. It may save the embarrassment of repeating that age-old excuse, "Gosh, Boss, it looked safe enough to me."

Speaking of Power

• A lot of water goes over the dam in the course of a month. Recent impressions range all the way from smoke over St. Louis and Fall sunshine in Kansas City to milling crowds on the power-show floor in New York. . . . Its hard to find time for long trips in this busy season, but St. Louis called and I managed to make Kansas City before the momentum ran out. My assigned job in St. Louis was the keynote address at the annual convention of the International Acetylene Association. With that off my chest, I found time for some good editorial visits.

. . . after St. Louis

Purina, for example—another one of those process plants. Somehow they hold a peculiar fascination. C. D. Barcley, who heads up the power services in many Purina plants from his office at the St. Louis factory, has plenty of technical problems to keep his mind in working order. In one plant he installs new boilers and coal stokers, while in another he must arrange for the mechanical firing of corncobs. Tomorrow he may have to lay out an air conditioning system for a company auditorium. . . . In every big process plant I visit—whether it be paper, textiles, glass, soap or food products—I find the power engineer's life a non-stop-merry-go-round.

. . . firing corncobs

On the way back to the hotel I stopped off at the Excelsior Leader Laundry to chat with Chief-Engineer Herr. It's worth noting that he burns that so-called coal from Illinois and yet contributes nothing to St. Louis' very considerable pall of smoke. A fine boiler room, well equipped and intelligently operated. . . . Another interesting sight was the lineup of big diesels on the erecting floor of the Busch Sulzer plant.

Perhaps my most vivid memory of St. Louis is the piping fabrication floor of Midwest Piping and Supply. Things were humming at the time of my visit, floor piled deep with materialized pipe dreams. No other term will fairly describe the twists and shimmies plant designers order and fabricators somehow produce with the aid of welding, bending fixtures and limitless ingenuity. . . . One gadget that caught my eye was a machine for cutting the welding edges of intersecting pipes. Without aid of cams or templates, but rather by the pure geometry of generation, the machined-guided torch cuts correctly bevelled matching edges for two pipes of any sizes, intersecting at any angle and with any desired offset of axes. All the operator has to do is to set the machine for the pipe diameters, angle and offset. The machine does the rest.

Out in Kansas City, Kansas, I had my first trip through the municipal steam-electric station. Some municipals may justify a reputation for careless operation, but you don't see anything like that at Kansas City. Among all the plants I have ever seen, either in America or abroad, and regardless of public or private ownership, this is ace high in upkeep, orderly operation, superb cleanliness and housekeeping.

. . . ace high

The mid-December number had a lot to say about power week in New York, A.S.M.E. plus Power Show. I still remember it as the best since the golden days of 1928.

Most recent adventure was a short excursion to an industrial power plant in Morristown, N. J. to see something new under the sun—a moving endless rubber pipe hoisting coal from track hopper to silo top. The whole thing is fantastic. The coal is in the pipe, but doesn't move through it; instead the pipe and the coal go off for a walk together like a rabbit in a snake's belly. First they move about 15 ft. horizontally, then 80 ft. straight up in the air, like the jumping rope of the thief of Bagdad (No liquor was served). Dumping its load at the silo top the empty pipe runs back to the ground, dangling freely without guide or support in the whole 80 ft. Then it slides back horizontally to the car hopper, ready for another round trip with another load of coal. . . . This coal handling outfit, first of its kind in the United States, started work about December 1 and was handling rice anthracite in great shape when I saw it. . . . Getting coal into an endless pipe and out again without any permanent openings is a real trick. During most of its excursion the pipe, ribbed and of heavy-walled cast rubber, looks like a single piece, but isn't. At the spots appointed for taking on load and discharging, top and bottom halves split apart and take different paths, coming together again with a dovetail lock when the new load is in or the old one is out. This process of "unbuttoning" and "buttoning up" is, of course, continuous. You'll find the details on page 39.

. . . jumping rope

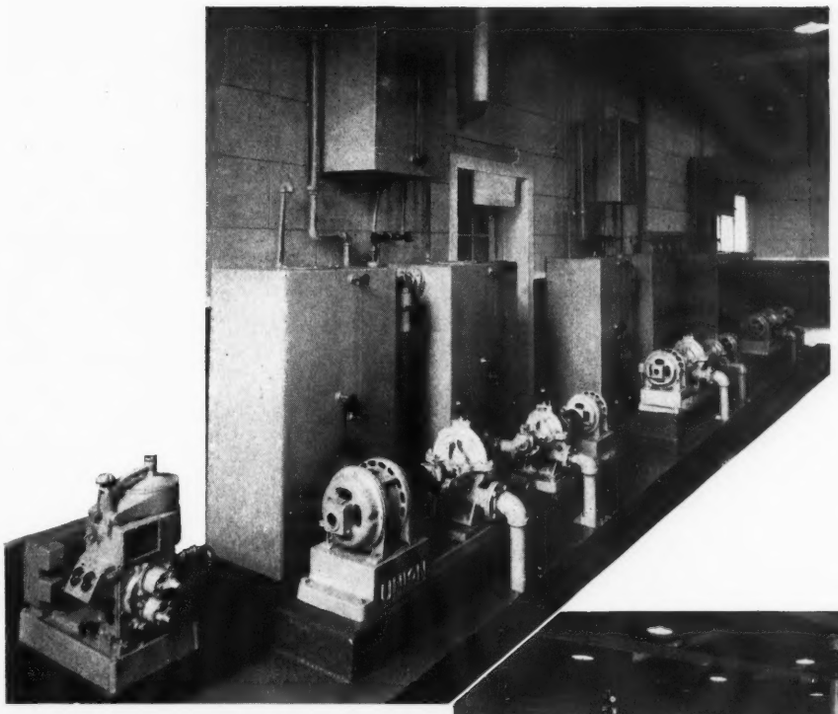
. . . halves split

I can't close without expressing my confidence in the new year. Beyond question it will be one of great activity in business and engineering lines. Everywhere, and in almost every line, I find manufacturing plants loaded up with orders. One builder of boiler auxiliaries, now running two 9-hour shifts, is forced to choose between a plant extension and three 8-hour shifts. Another reports the biggest sales month in his history. Drafting rooms are bulging with designers, estimators, draftsmen and tracers—all busy. *Power* faces its bigger task with a staff enlarged and geared for action.

PHIL SWAIN
Editor

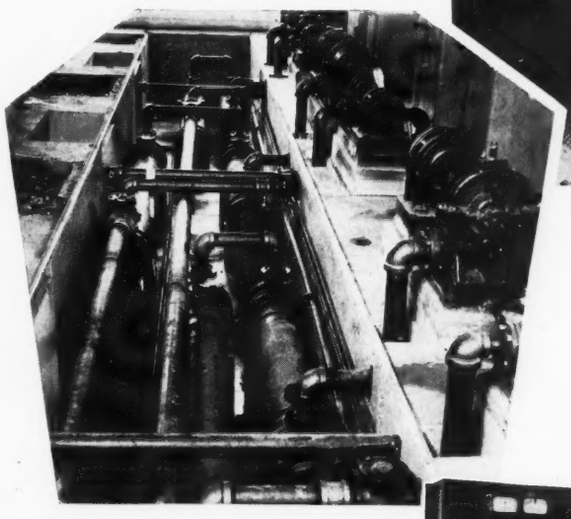
HOOSIER Horsepower

Tipton, Ind., goes diesel

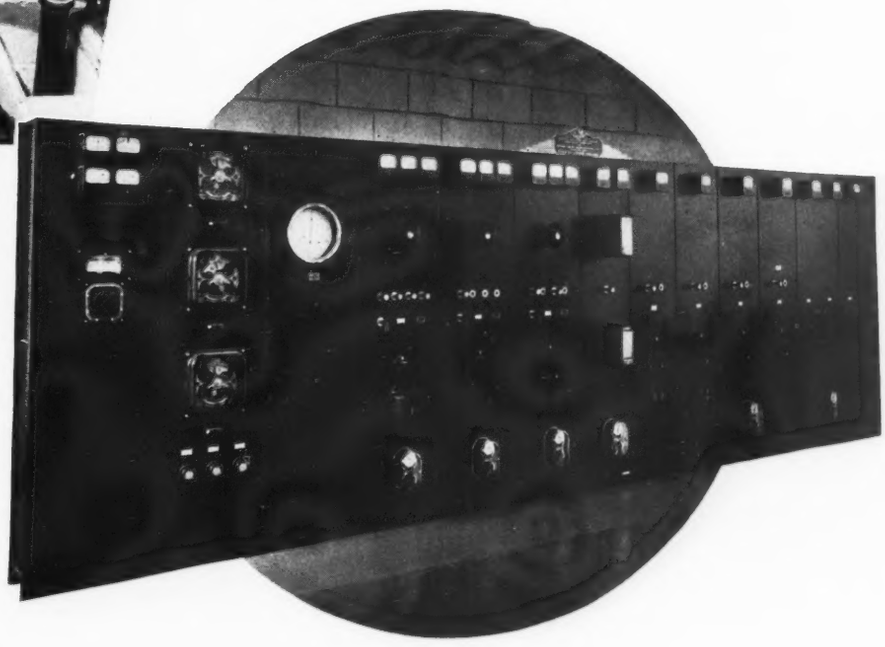


There are individual circulating-water pumps, lubricating-oil and fuel tanks. Lube is pumped from the engine sump through a screen strainer, then forced through a duplex plate filter to a 200-gal. tank. A second pump integral with the engine forces it through a cooler and screen strainer to the bearings

Three 8-cyl., 700-hp., 4-cycle, Winton diesels are direct-connected to 485-kw. 2400-volt, 3-phase, 0.8-pf., 60-cycle alternators and exciters. Woodward isochronous governors are on each unit. The plant delivers 11.2 net kw.-hr. per gal. of fuel and is expected to produce 1,250,000 kw.-hr. per yr. Day peak is 900 kw., night peak 400

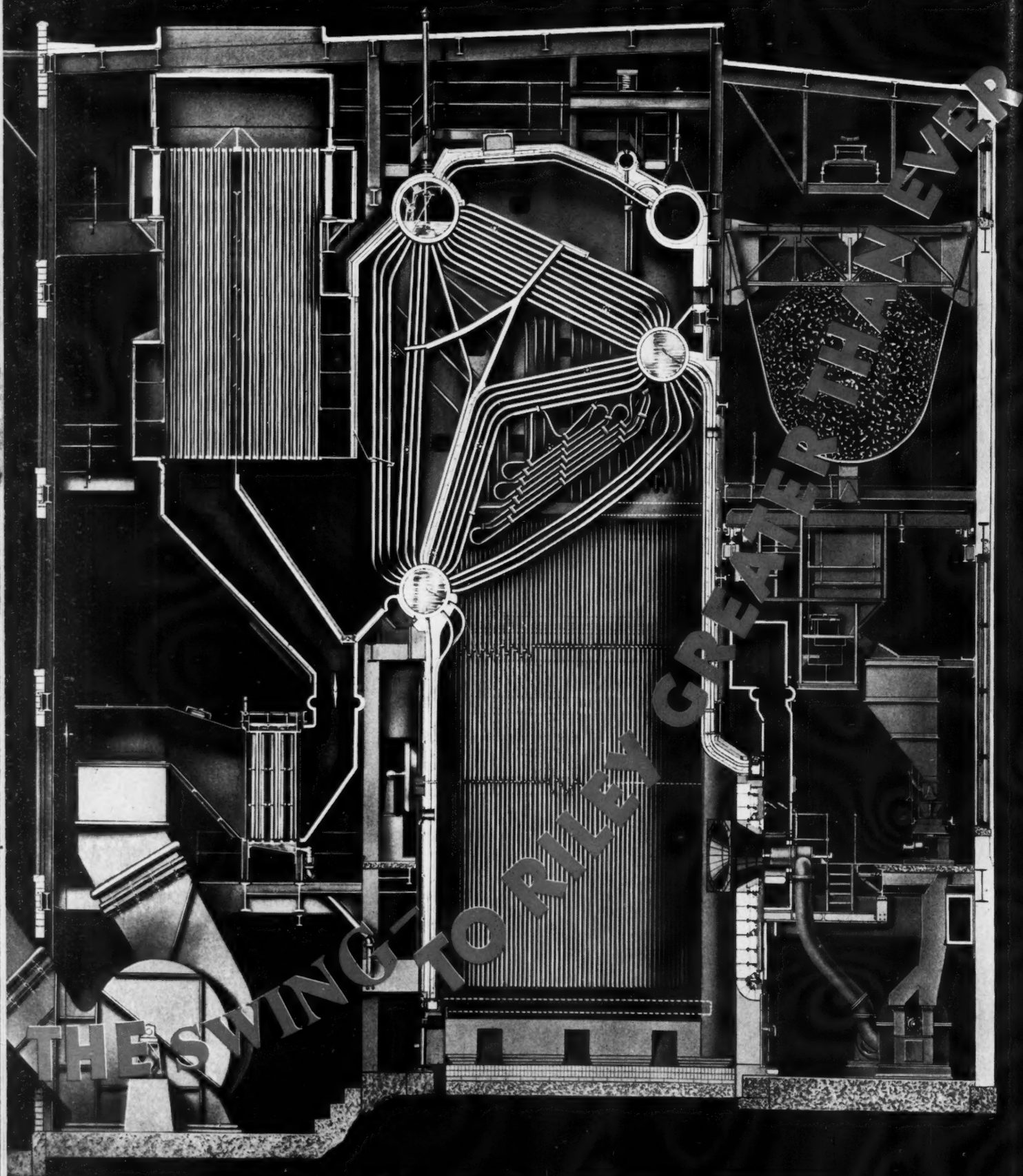


Circulating-water pumps, heat exchangers, oil coolers and piping. A closed cooling system is thermostatically controlled to hold jacket temperatures constant. Raw water goes to a 1,000-g.p.m. cooling tower. Raw-water pumps are 300-g.p.m. units, soft-water pumps 150 g.p.m.



Manually operated, remote-control switchboard has customary instruments, regulators, integrating and graphic meters, together with circuit panels. It also has a flush-mounted master clock for accurate timing of system frequency

1936-RILEY'S



RILEY

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BIGGEST YEAR

CARRYING RILEY SALES TO BY FAR THE HIGHEST IN RILEY HISTORY . . .

Thanks to You . . . the users of steam generating equipment who, because of your preference for RILEY Equipment, *made this record possible*

Record sales cannot be made without record breaking equipment. To break sales records—outstanding performance of existing installations—satisfied users are necessary. 61.4% of Riley's 1936 sales were repeat orders from satisfied users. Excellent performance and complete satisfaction are the real reasons back of Riley's tremendous sales volume in 1936—why company after company has swung to Riley.

Words on paper cannot adequately describe neither Riley's great progress during this, the worst of depressions, nor the efficient, satisfactory performance of Riley Steam Generating and Fuel Burning Equipment. To obtain the true picture you must see with your own eyes the way Riley equipment performs.

When considering either steam generating or fuel burning equipment you owe it to yourself and your company to visit a number of recent Riley installations. Then you will readily understand why the swing to Riley in 1936 was greater than ever—and why 1937 will be even a greater Riley year.

Follow the trend! When you think of steam generating or fuel burning equipment, think of Riley.

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•

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Large Eastern Oil Refinery—Repeat order
1—300,000 lbs./hr.—650# pressure—740° F. steam

Commonwealth & Southern Corporation
Central Illinois Light Co. — E. Peoria, Ill.
1—300,000 lbs./hr.—900# pressure—875° F. steam

West Virginia Pulp & Paper Co. — Charlestown, S. C.
2—225,000 lbs./hr.—600# pressure—720° F. steam

West Virginia Pulp & Paper Co. — Williamsburg, Pa.
2—71,500 lbs./hr. 600# pressure—750° F. steam

Lynn Gas & Electric Co. — Lynn, Mass.
1—205,000 lbs./hr.—430# pressure—810° F. steam

Holyoke Water Power Co. — Holyoke, Mass.
1—170,000 lbs./hr.—675# pressure—750° F. steam

Large Chemical Corp. — S. Charleston, W. Va.
2—100,000 lbs./hr.—600# pressure—760° F. steam

Standard Oil of California — Richmond, Calif.
3—125,000 lbs./hr.—900# pressure—760° F. steam

Socony-Vacuum Co. — Naples, Italy
2—48,500 lbs./hr.—752# pressure—712° F. steam

Bahrein Petroleum Corp. — Persia
2—106,000 lbs./hr.—600# pressure—720° F. steam

Fort Bend Utilities — Sugarland, Texas
1—160,000 lbs./hr.—440# pressure—750° F. steam

North Dakota Power & Light Co. — Beulah, N. D.
1—56,000 lbs./hr.—275# pressure—625° F. steam

Publicker Commercial Alcohol Co. — Philadelphia, Pa.
1—275,000 lbs./hr.—475# pressure—650° F. steam

McAndrews & Forbes Co. — Camden, N. J.
2—100,000 lbs./hr.—500# pressure—650° F. steam

Newport Electric Co. — Newport, R. I.
2—60,000 lbs./hr.—475# pressure—765° F. steam

General Motors Corp.
Guide Lamp Co. — Anderson, Ind.
1—50,000 lbs./hr.—275# pressure—577° F. steam

Bemis Bag Company — Peoria, Ill.
1—70,000 lbs./hr.—275# pressure—600° steam

Tsishuyen Electricity Works — China
110,000 lbs./hr.—233# pressure—680° steam

Upper Michigan Power & Light Co. — Escanaba, Mich.
1—90,000 lbs./hr.—450# pressure—650° F. steam

University of Minnesota — Minneapolis, Minn.
1—100,000 lbs./hr.—307# pressure—625° F. steam

Imperial Paper & Color Co. — Glens Falls, N. Y.
2—50,000 lbs./hr.—300# pressure

•

FUEL BURNING EQUIPMENT

In addition to the fuel burning equipment for most of the above jobs

Hartford Electric Light Co.—Repeat order — Hartford, Conn.
4—13,000 lbs./hr. pulverizers

Power Operating Co. — Cahokia
10—20,000 lbs./hr. pulverizer

Carnegie Illinois Steel — Youngstown, Ohio
2—20,000 lbs./hr. pulverizer

City of Rocky Mount — North Carolina
Multiple Retort Clinker Grinder for 100,000 lbs. steam per hour

City of Kinston — North Carolina
Multiple Retort Clinker Grinder Stoker for 71,500 lbs. steam per hour

Single retort underfeed stokers—too many to enumerate

RILEY STOKER CORPORATION
Worcester, Massachusetts

SINGLE MULTIPLE RETORT UNDERFEED STOKERS - TRAVELING GRATE STOKERS
PULVERIZED COAL EQUIPMENT AND BURNERS - BOILERS - SUPERHEATERS
ECONOMIZERS - WATER WALLS - AIR HEATERS - STEEL-CLAD SETTINGS

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA
ST. LOUIS CINCINNATI HOUSTON CHICAGO ST. PAUL KANSAS CITY LOS ANGELES ATLANTA

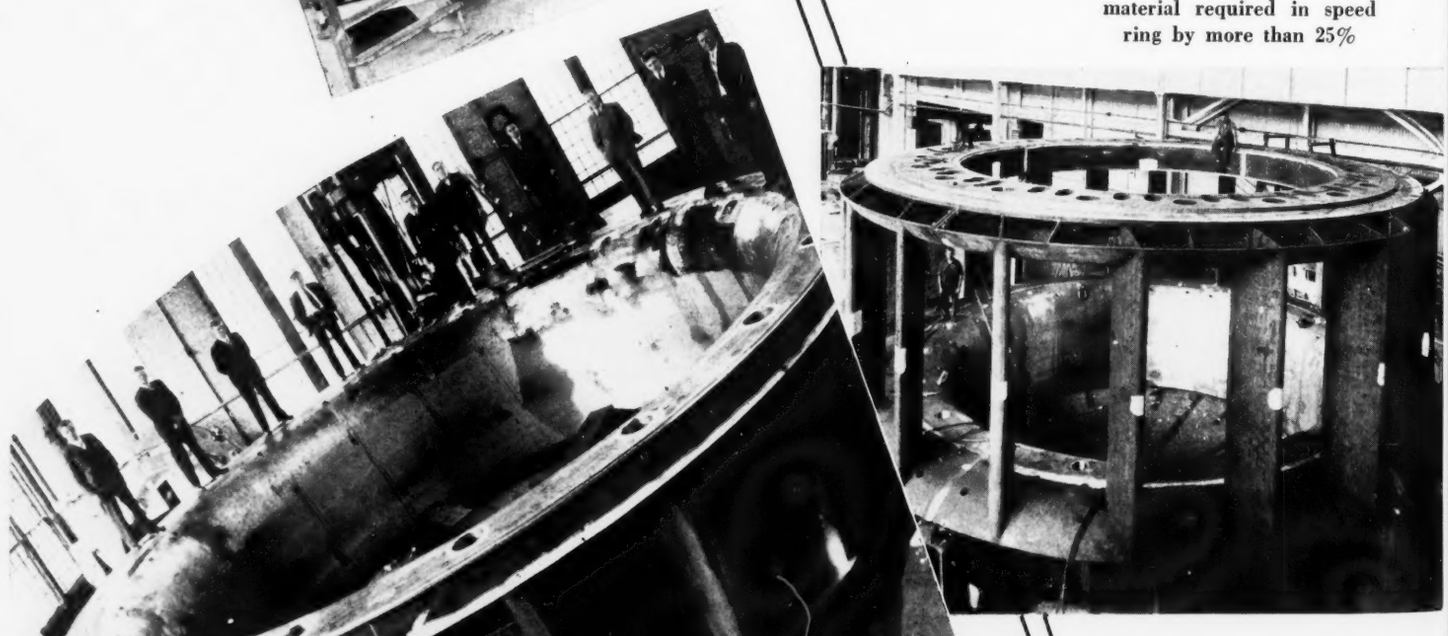
BOILERS • WATER WALLS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • PULVERIZERS • UNDERFEED & TRAVELING
GRATE STOKERS • FLUE GAS SCRUBBERS

BONNEVILLE

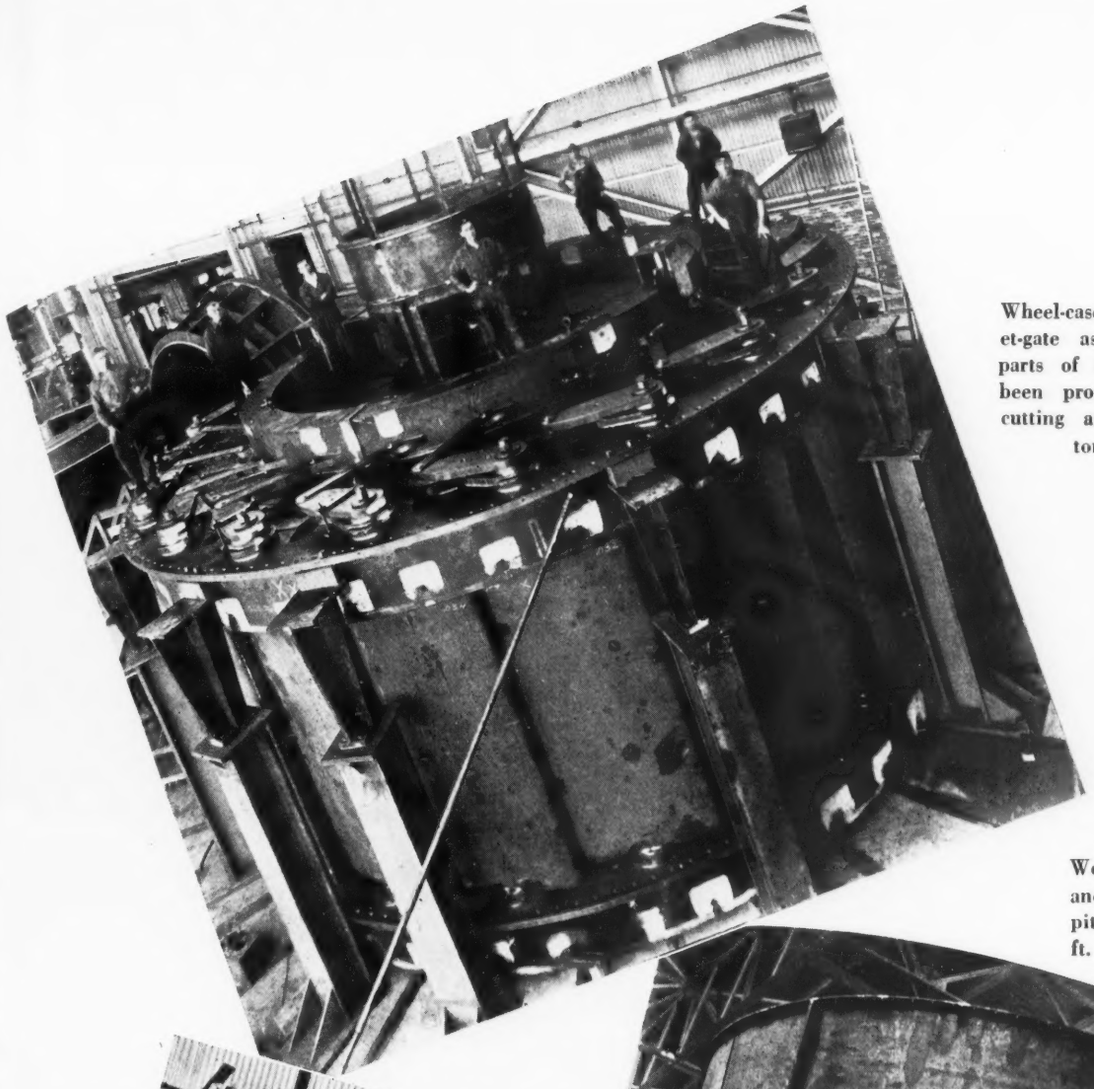
Turbines, two Kaplan type, rated 66,000 hp. at 50 ft. head, are the highest-power units of their type in the world. They are the first large ones to have major parts of fabricated, welded plate steel. Approximately 50,000 lb. of welding rod and more than 22,000 linear feet of welding bead were laid by S. Morgan Smith Co. in their construction

Inner crown plate on a boring mill after being fabricated and welded from plates and shapes

Speed-ring, throat-ring and outer crown-plate assembly, with an outside diameter of 36 ft. 6 in. Welding reduced material required in speed ring by more than 25%

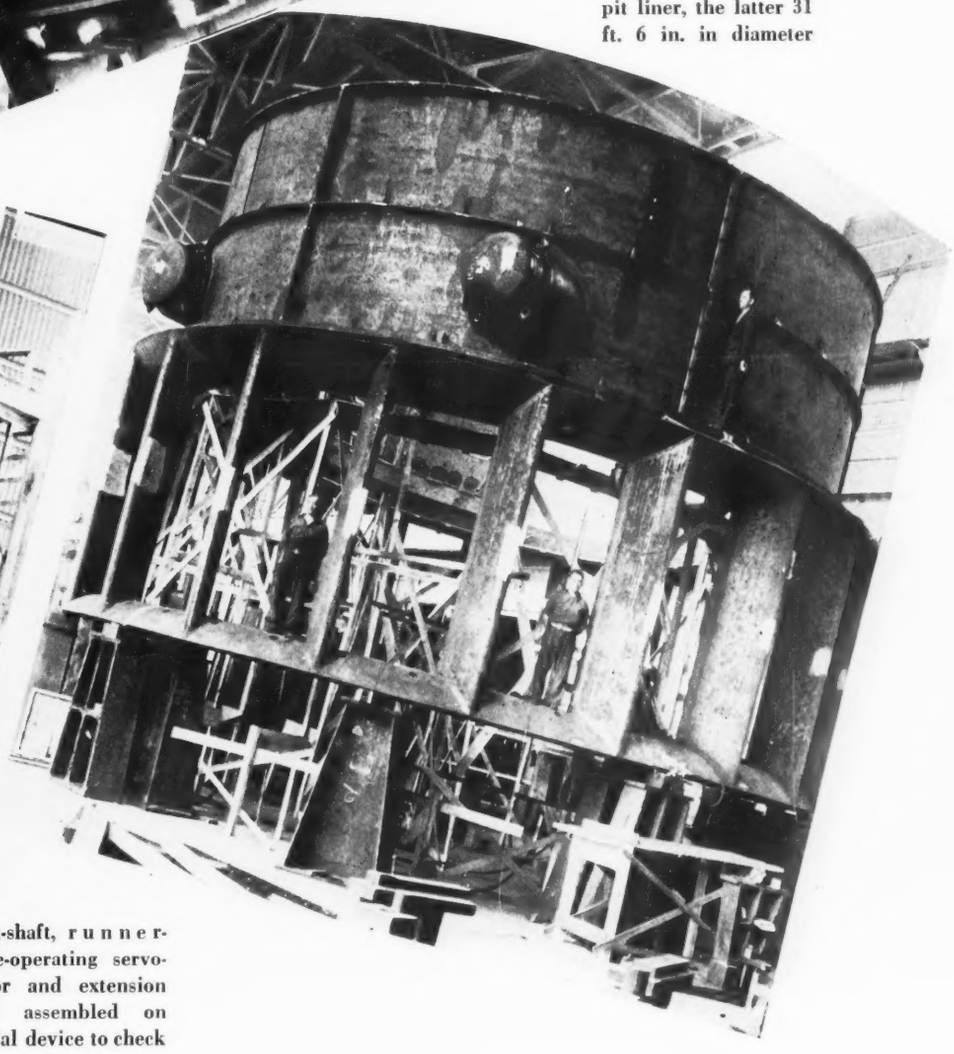


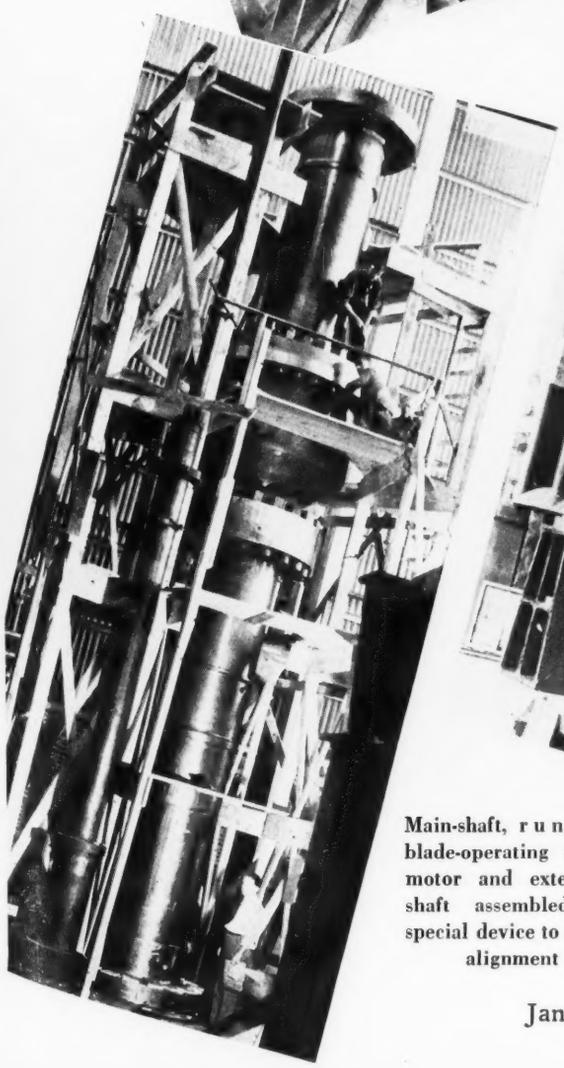
Welded throat liner for one of the runners which are 23 ft. 4 in. in diameter and weigh 120 tons each and will discharge 12,000 c.f.s. at full load



Wheel-case and wicket-gate assembly, all parts of which have been produced with cutting and welding torches

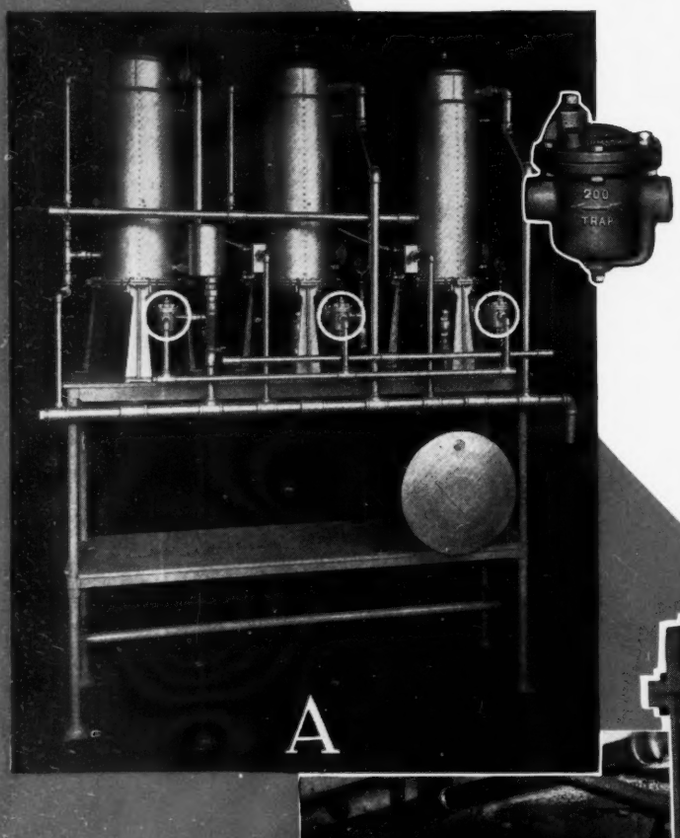
Welded speed ring and lower section of pit liner, the latter 31 ft. 6 in. in diameter





Main-shaft, runner-blade-operating servomotor and extension shaft assembled on special device to check alignment

A TRAP FOR

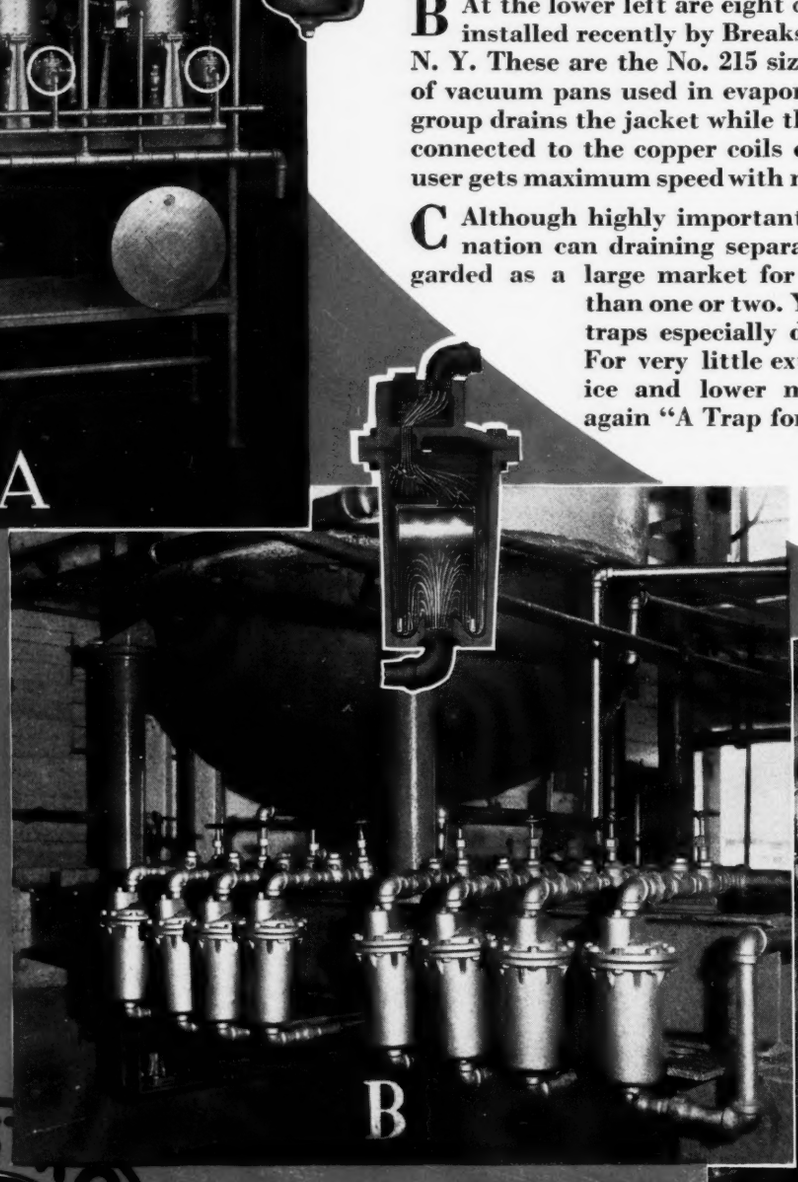


A

A Tops for purity and sterility goes to the water used in preparing biological serums and vaccines. To get water of this caliber, the pharmaceutical laboratories of Armour & Co., Chicago, uses the triple distillation unit pictured at the left. The maker of the unit, Precision Scientific Co., of Chicago, regularly uses No. 200 Armstrong traps on all steam chests to insure faultless service.

B At the lower left are eight of the 55 new Armstrong traps installed recently by Breakstone Bros. Dairy Co., Walton, N. Y. These are the No. 215 size and are connected to a pair of vacuum pans used in evaporating milk. One trap in each group drains the jacket while the other three are individually connected to the copper coils on the inside of the pan. The user gets maximum speed with minimum steam consumption.

C Although highly important, by no stretch of the imagination can draining separators on steam engines be regarded as a large market for traps. Few plants need more than one or two. Yet Armstrong has long offered traps especially designed to handle these jobs. For very little extra cost, users get better service and lower maintenance costs . . . . Here again "A Trap for Every Purpose" is more than



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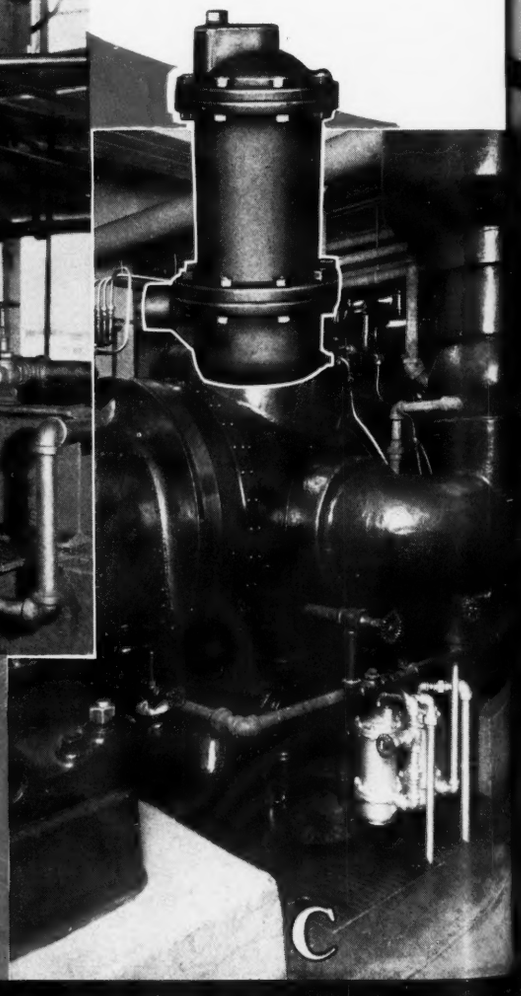


C

Hard Jobs or Easy *-they're all the same to an*

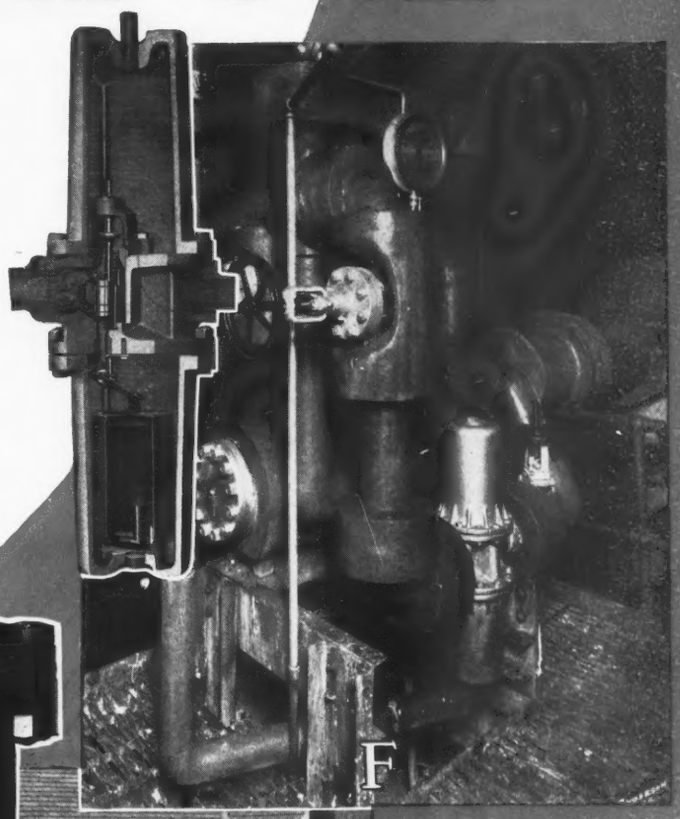
EVERY PURPOSE

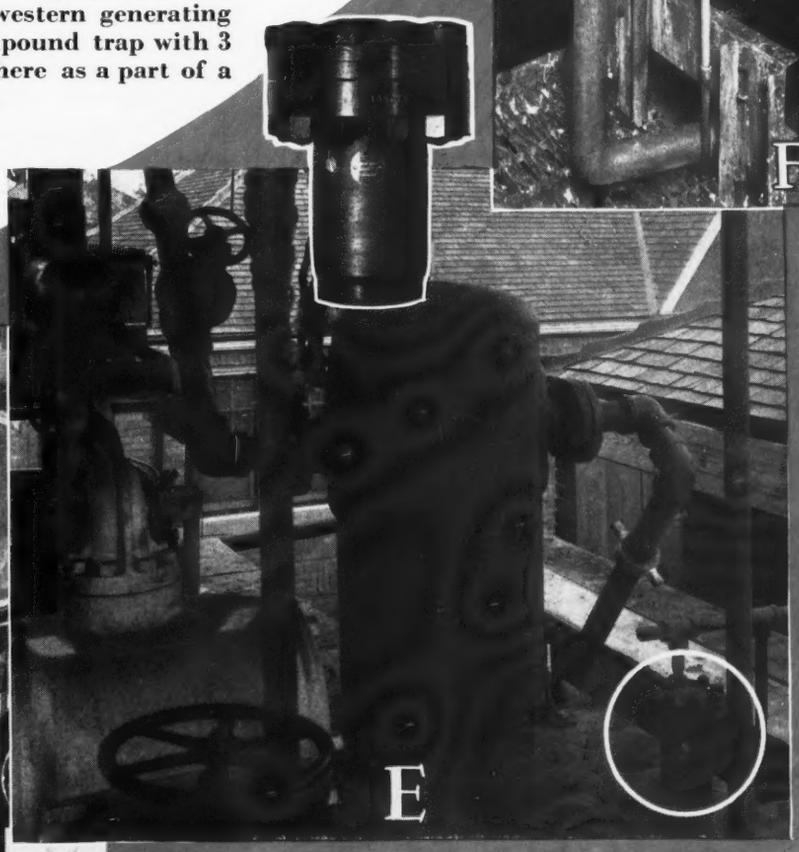
just a slogan with Armstrong! The two shown below are No. 223's in the new Herman Memorial Hospital, Houston, Texas.

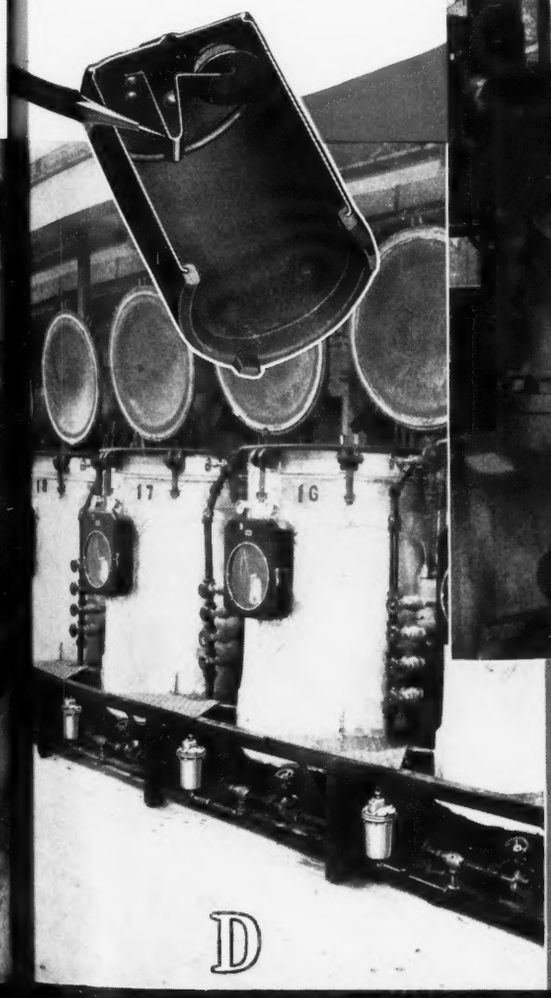
D Below are a few of some 90 retorts which one of Chicago's big packers has equipped with Armstrong traps. No traps could ever handle this job until Armstrong solved the problem by offering the unique thermic bucket (see inset) with the vent set to stay open and discharge air up to a temperature of 240° F.

E At the lower right is the trap oil well drillers swear by and not at. It's the No. 313 forged steel trap for pressure from 250 up to 600 lbs. It is just right for draining separators on steam lines going to drilling rigs and slush pumps. This one is on a rig run by the Brown Drilling Co. of Oklahoma City. The inset shows what an Armstrong trap for 1350 lbs. pressure looks like.

F Power engineers will agree that 150,000 lbs. of steaming hot water is a big load for any trap to handle in an hour. Take a look at the trap (at the right) that does it on occasion for a big mid-western generating station. This is a No. 237 compound trap with 3 inch connections. It is used here as a part of a continuous blow-down system.







D

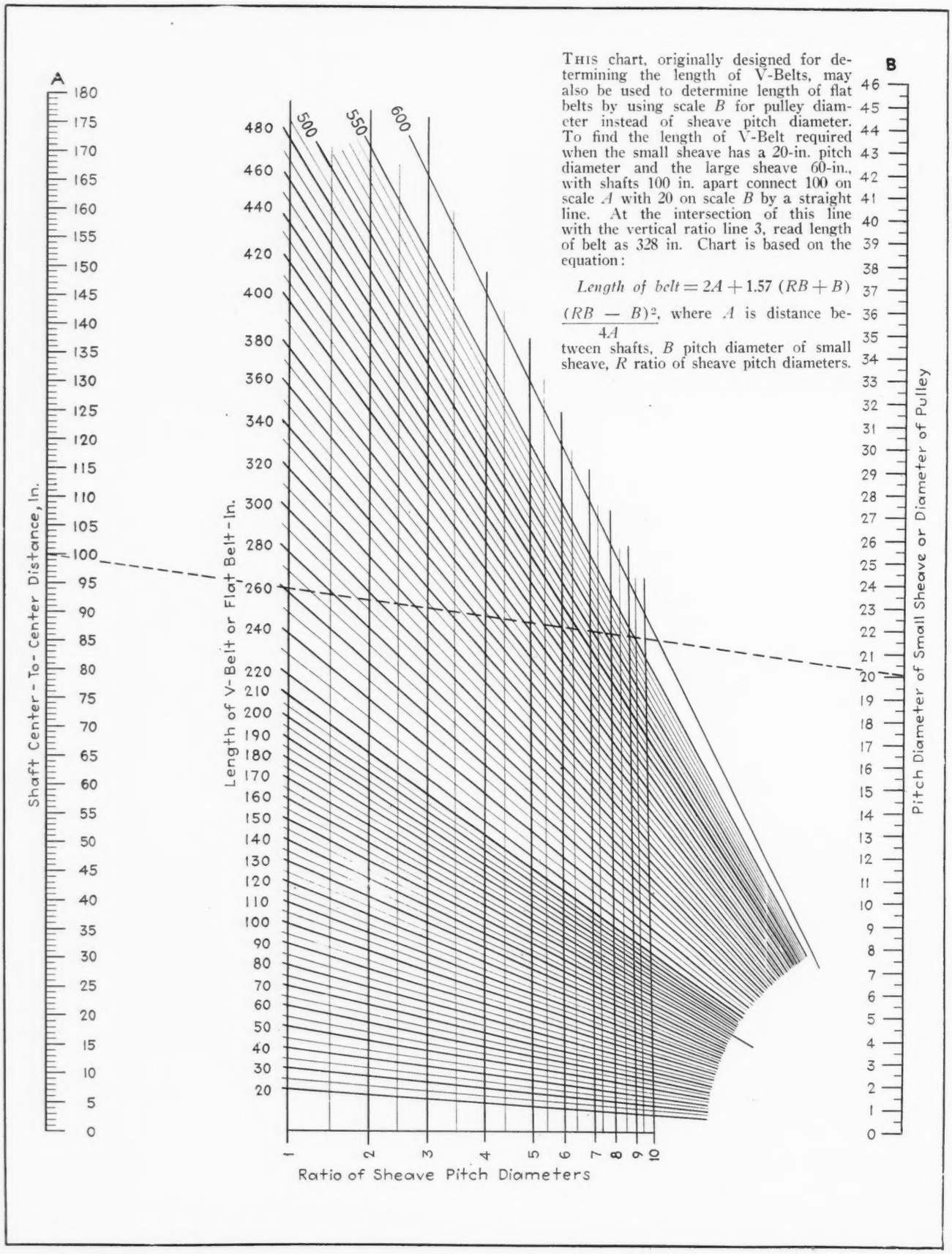
ARMSTRONG MACHINE WORKS

812 MAPLE STREET • THREE RIVERS, MICH.

ARMSTRONG TRAP

Number 53

Chart to Determine Length of V-Belts



THIS chart, originally designed for determining the length of V-Belts, may also be used to determine length of flat belts by using scale B for pulley diameter instead of sheave pitch diameter. To find the length of V-Belt required when the small sheave has a 20-in. pitch diameter and the large sheave 60-in., with shafts 100 in. apart connect 100 on scale A with 20 on scale B by a straight line. At the intersection of this line with the vertical ratio line 3, read length of belt as 328 in. Chart is based on the equation:

$$Length\ of\ belt = 2A + 1.57\ (RB + B) + \frac{(RB - B)^2}{4A}$$

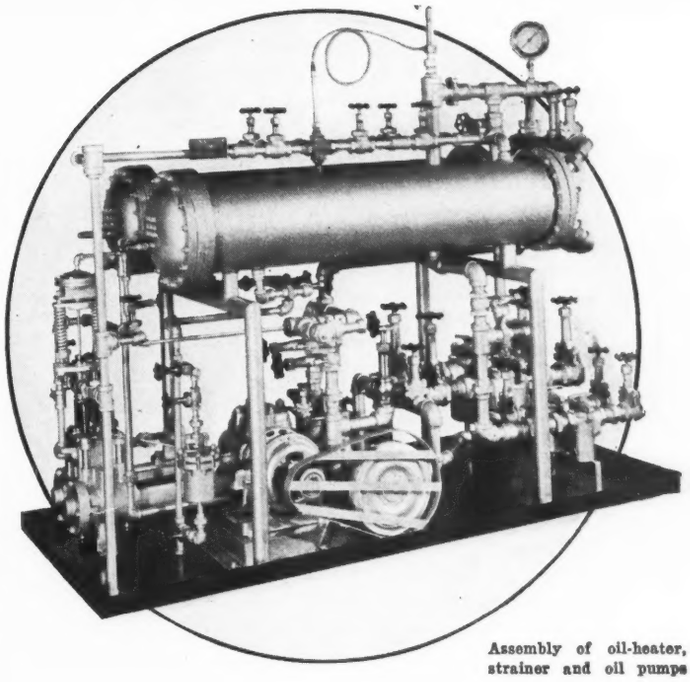
where A is distance between shafts, B pitch diameter of small sheave, R ratio of sheave pitch diameters.

Courtesy Allis-Chalmers Mfg. Co.

© POWER

Pointers on OIL HEATERS

By Kalman Steiner and Theodore J. Kauders

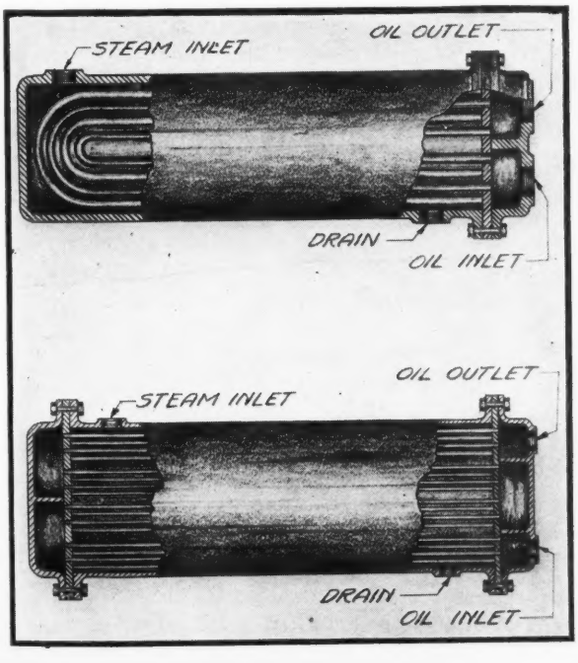


Assembly of oil-heater, strainer and oil pumps

PREHEATING fuel oil is principally needed to bring the viscosity of heavy oils within the range of utility as liquid fuel. But there are other factors of less importance that also enter, and which make preheating desirable for other reasons. First, since combustion is a chemical reaction, which is accelerated by increasing the temperature of the reacting substances, preheating fuel oil results in faster and better combustion. Secondly, atomization is also a function of viscosity, and most burners can break up the oil more effectively at lower than at higher viscosities. It follows that better atomization will result from preheated oil than from cold oil, assuming that the cold oil itself could be atomized at all, as would be the case, for instance, with No. 5 oil in a horizontal rotary burner. Better atomization in turn means more intimate mixing with air—hence less excess air will be used in combustion. Finally, viscosity affects fluid flow, to the extent that lower viscosity means less wear on pumps, less power required for pumping, and smaller pipe sizes required for equivalent quantities pumped.

The relationship between viscosity and temperature is best illustrated by plotting a curve with these two factors as co-ordinates. While each oil will have its own characteristic curve, all such curves will be logarithmic curves on ordinary co-ordinate paper. It follows that the same data plotted to logarithmic scale for viscosity and an arithmetic scale for temperature will be a straight line. Each curve has a use; the former will show at what temperature the viscosity "breaks," or when additional heating results in but little further reduction of viscosity, and the latter will enable a curve to be laid out from only two sets of data (viscosity at two different temperatures) so that the viscosity at any other temperature may be readily determined.

U-tube oil heater with 2 passes and straight-tube oil heater with 4 passes



In general, heating of fuel oil is accomplished by pumping it through a heater maintained at a high temperature. Three heating media are in general use: steam, hot water, and electricity. A preheater must, therefore, embrace these elements: a heating medium, a surface of contact to transfer heat from the heating medium to the oil, and a means of conducting both oil and medium through the heater.

Heat transfer varies with viscosity of the oil. This can readily be appreciated when it is considered that the speed with which heat is removed from the surface of contact between oil and metal must depend on the freedom with which hot particles of oil can move away from the surface and be replaced by colder particles. In viscous liquids, hot particles tend to cling to the surface, forming an insulating layer around the colder main body of oil thereby also reducing the temperature differential between heating medium and oil. In less-viscous liquids, like water, the heated particles immediately set up convection currents, and the resultant turbulence aids in transferring heat into the body of the liquid. This is true to a lesser degree for lighter grades of fuel oil, but as the oil increases in weight and viscosity, the tendency towards convection currents is diminished.

Another factor governing rate of heat transfer

is the amount of free carbon suspended in the fuel oil. When carbon deposits upon the tube surface, together with enmeshed oil, the resulting scale retards heat transfer, as such a formation simply places additional resistance between the heating medium and the oil to be heated.

If all other conditions are held constant, heat transfer varies as a constant multiplied by the square root of the oil velocity. Just what limiting velocity should be used is a matter of practical experience; it cannot be too high, as that would create unnecessary friction losses, and cannot be too low, as that would cause deposition of sludge on the walls of the heater tubing.

In general, the velocity should at least be as high as that minimum which yields turbulent flow instead of streamline flow, as this not only promotes heat transfer but also aids in preventing formation of free carbon scale on the tubes. However, it is probable that velocity is a more important factor in keeping free carbon and other sediment in motion instead of allowing it to deposit on the tube.

Commercial forms of preheaters can be classified as:

I Shell-and-tube type with heating medium in shell
  1. Straight-tube
  2. U-tube
  3. Spiral coil

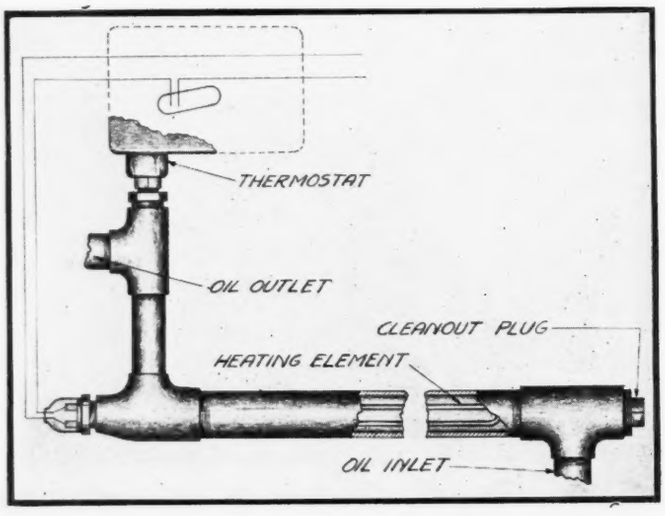
II Shell-and-tube type with heating medium in tubes

III Concentric tubes

Although each type has its own advantages and disadvantages, some have only in their favor the element of low first cost. Others may involve a somewhat higher investment, but offset this by better performance in operation. Some factors to consider in judging the merits of any one type of heater are: ease and cost of installation, accessibility for cleaning, simplicity of replacing parts, compactness and space requirements, etc.

The straight-tube type seems to be a popular form, and most manufacturers offer it. One of its manifest advantages is that the tubes can be cleaned without opening any pipe connections. Generally speaking, these heaters are built with steel shells and steel tubes; the steel shell offers great strength for resisting high working pressures, and the steel tubes offer better resistance to corrosion than would copper tubes, considering the sulphur present in varying amounts in all fuel oils.

Electric oil heater



In selecting an oil heater for a specific application, consider the following, for they control the degree of satisfaction that will be derived from the heater's operation:

1. Proper working and test pressure. All high-pressure vessels should be built in strict conformance to A.S.M.E. requirements.
2. Number of passes, which together with No. 3 below determines the heating area.
3. Number of tubes per pass, and the diameter of the tubes, for these determine the velocity.
4. The actual amount of heating surface, which should be certified by the builder as adequate under the conditions of service.
5. Diameter of the tubes, which must not be so small as to offer difficulty in cleaning and unduly increase friction loss, and must not be so large as to permit stratification within the tube.
6. Capacity must be ample, and should be sized for the total oil pumped, so that surplus may be returned hot to storage.

Every installation of an oil preheater should include a pressure-relief valve to guard against excessive pressures resulting from oil expansion.

Automatic Control

Automatic temperature control should be provided to maintain oil temperature within desired limits. When steam is the heating medium, this is readily accomplished by throttling with a thermostatic steam valve actuated from a bulb immersed in the stream of hot oil. When hot water is the medium, thermostatic control is not so easy, although if the water is pumped through the heater by a circulating pump, the pump motor can of course be placed under thermostatic control. Otherwise, thermostatic valves in the gravity water circulating line can also be used, but will not give the close control that is possible in the case of steam.

A steam trap of ample capacity to handle the condensate should be installed to avoid water hammer and for economy of steam consumption. A bucket trap is the preferred form for this use.

Hot-water exchange type heaters should be tapped into the boiler about 4 in. below normal water line. The pipe from the boiler to the top of heater should pitch toward the heater to facilitate water circulation, and for the same reason the return pipe from heater to boiler should pitch toward the boiler. Circulating pumps on larger sizes of heaters avoid the need for running large pipe sizes, and increase heater capacity somewhat by increasing the velocity of the water.

Several manufacturers offer excellent types of ready-made electrical heater elements for this work, that can be directly incorporated into oil heaters. The heater itself consists essentially of a shell containing the oil, the heater elements, and a thermostatic regulator to control the current from the oil temperature. When the electrical load is fairly high, above 1000 watts, it is necessary to use either a high-capacity thermostat to handle the heater current, or else a relay to handle the heater current while the thermostat controls the circuit actuating the relay.

This Pipe Goes Places

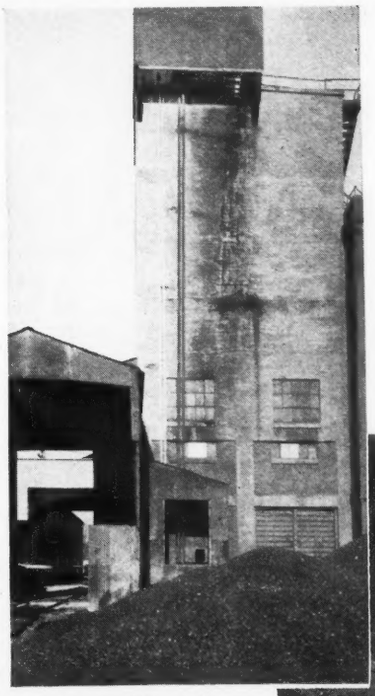


Fig. 1—Right-hand pipe is full of coal and running up at 300 ft. per min. Left-hand pipe runs down empty to hopper beneath track

THIS country's first coal-handling system using a traveling pipeline for transporting coal went into operation last month at the Whippany, N. J., plant of Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc. This conveyor operates on an entirely new principle. A heavy-walled rubber tube, split longitudinally, divides to receive coal from the track hopper, closes, then rises 80 ft. and opens to discharge into a storage silo. *Power* editors saw it Dec. 10.

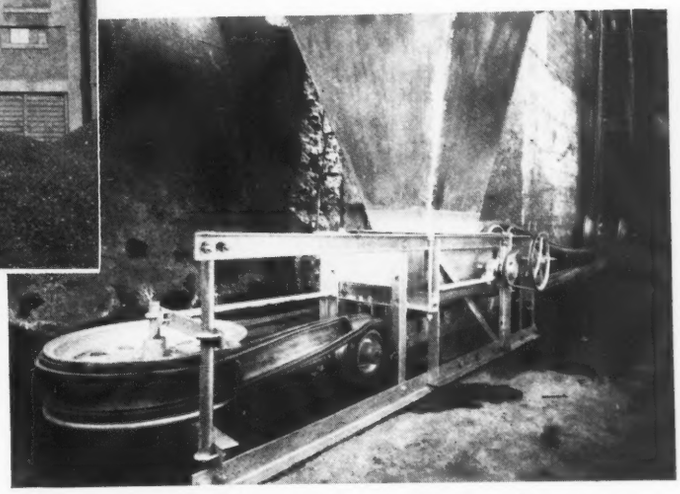


Fig. 2—Loading station beneath track. Loading half of pipe (in foreground) is rolling and twisting into position under hopper. Leaving hopper, loaded, it mates with cover half, gets a sealing twist and rises (right background)

Replacing a bucket elevator, the new system handles 9 tons of anthracite rice coal an hour. Capacity is based on the 2-in. internal-diameter conveying tube traveling 300 ft. a min. Mechanical simplicity, cleanliness, quietness and freedom from vibration are notable.

Each half of the moving conveyor tube is really an endless belt with a chain embedded in the rubber to give mechanical strength, the chain carrying the load and the rubber acting as a casing for the material. Double tongue-and-groove joints seal when the belts are put together. After the halves are in place, making a tube, the assembly is twisted like a rope, compressing the joints, making a tighter seal and preventing the tube from opening.

The loading half of the conveyor is fitted with disk-like partitions or flights which pick up a full load when passing through the loading hopper and prevent slipping and backing on the vertical lift. This half of the conveyor is always longer than the other, or cover half, to provide a means of loading.

Loading at the track hopper is made possible by separating and guiding the two halves of the tube around separate sheaves. Coal flows from the hopper into the load belt, which then passes under the sheave around which the cover belt is running, joint side out. This forces the two sections together. Guides clean the grooves and insure alignment.

In emptying the tube, guide rollers first remove the twist from a section directly over the discharge hopper, leaving the joints vertical. The halves separate, dump the load, pass over separate drive pulleys, and are resealed. Then the twist is restored and the conveyor returns to the loading hopper, **Fig. 3**.

A 3-hp. motor connected by a speed-reducing v-belt drive to the sheaves at the top of the vertical lift drives the conveyor. All pulleys and idlers, with the exception of the drive sheave, have integral anti-friction bearings and revolve on stationary shafts. Take-ups are provided at all necessary points to maintain tension on the tube. The light weight of the tube reduces to a minimum the strength of the supporting structure required.

Should it be necessary to lengthen the conveyor, a section can be inserted, the chains connected and the assembly vulcanized in the field. Properly located pulleys guide the pipe over any desired path.

Credit is due R. H. McLeod, supt. of Manhattan Rubber Division of Raybestos-Manhattan, Inc., H. S. Johns, inventor of the traveling tube, and A. R. Brown, president, and S. S. Ball, vice-president of the Johns Conveyor Corporation, Newark, N. J., builder of the conveyor, for information here used.

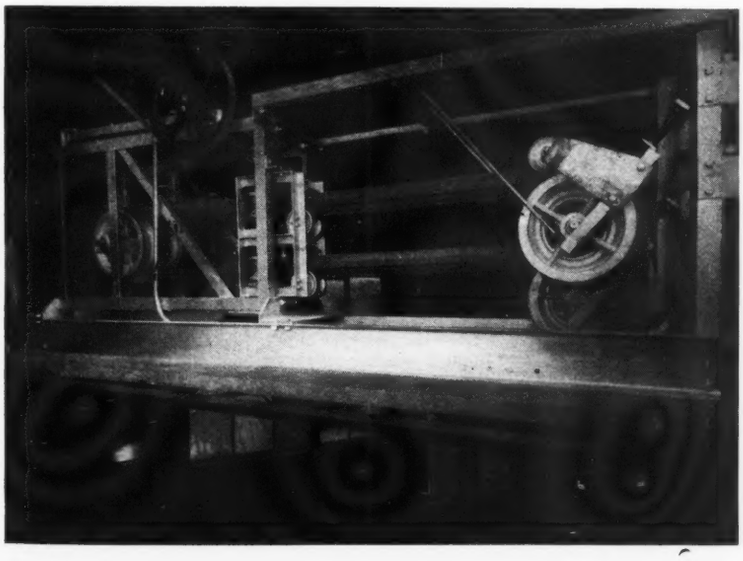


Fig. 3—Unloading station above silo. Driving pulleys (left) turn clockwise. Lower (loaded) pipe moves left without twist to idler frame. Pipe joints are vertical. Halves separate at left of idler frame, dump coal and pass around pulleys back to idler frame, there mating again. In right foreground is empty pipe descending

What Capacity Freon Compressor?

A theatre air-conditioning system lacks cooling capacity. The engineer thinks his compressor is too small. Here is his question and the answer.

As Answered by

A. G. Solomon

The Question

DURING *the hot weather of last summer it was impossible to maintain proper temperature or humidity in the theatre where I am engineer. The plant is new and is considered first class. There are two 2-cyl. vertical single-acting compressors, direct-connected to synchronous motors operating at 257 r.p.m. Freon is the refrigerant.*

In hot weather, water going to the condensers has a temperature of 82 deg. Temperature of liquid Freon, leaving condensers, is almost constant at 85 deg. To obtain good results, it is necessary to maintain water going to the air washers at 45 deg. But during hot weather, this temperature could not be brought below 54 deg.

Before installing this plant we signed a contract containing a clause that the refrigerating equipment would be of sufficient capacity to handle removal of 1,800,000 B.t.u. per hr. and give an inside temperature not less than 8 deg. below outside temperature.

Since I contend that the compressors are not large enough, I am not giving piston diameter and stroke. I want to know how many cubic inches of compressor displacement are necessary. How much Freon in pounds and cubic feet must be circulated? What is the actual refrigerating capacity of compressors that will remove 1,800,000 *B.t.u. per hour?*

—E.M.C.

The Answer

WORKING OUT this problem from the information given is not an easy task. Local operating conditions and variations play an important part. A copy of the hourly readings of the daily operating log would be a great help in giving exact and detailed information. But the problem can be solved in an understandable manner so that any average engineer can substitute values to suit his own particular plant.

Known facts, as set forth in the question, are:

Total amount of heat to be removed 1,800,000 B.t.u. per hr.

Temperature at which it is necessary to carry refrigerated water, 45 deg.

Temperature of water going to Freon condensers, 82 deg.

Temperature of liquid Freon leaving condenser, 85 deg.

Two double-cylinder vertical single-acting compressors operating at 257 r.p.m.

One ton of refrigerating capacity is equal to 288,000 B.t.u. per 24 hr., 12,800 B.t.u. per hr. or 200 B.t.u. per min. To remove 1,800,000 B.t.u. per hr. divide 1,800,000 by 12,000, which gives 150 tons, the theoretical refrigerating capacity necessary.

But this statement means very little as far as the size and speed of the compressor is concerned. Nor is it a reliable rating when all the factors are considered that must be checked before actual displacement of the needed compressors can be determined.

To make the answer of this question of real value we must go into details of actual operation and heat removal.

First consider Freon temperature in the different parts of the system. Liquid Freon leaving the condenser is at 85 deg., and assuming it is neither heated nor cooled, it passes through the expansion valve at 85 deg. To maintain a refrigerated-water temperature of 45 deg., it is necessary to have an evaporating temperature of about 37 deg. This gives an 8-deg. temperature difference and insures rapid heat transmission and complete vaporization of the refrigerant.

The first step is to determine the refrigerating effect of one pound of Freon when evaporated under these conditions. From tables giving the thermodynamic properties of Freon, the heat content of the 85-deg. liquid is 27.48 B.t.u. per lb. Heat content of the 37-deg. vapor is 82.38 B.t.u. per lb. Then 82.38—27.48=54.9 B.t.u.

As 12,000 B.t.u. per hr. represents 1 ton of refrigerating capacity. 12,000 divided by 54.9 or 218.5 lb. is the amount of Freon that must be evaporated and circulated each hour to produce 1 ton of refrigerating capacity in 24 hr. This is the theoretical amount and does not allow for any loss. It assumes each pound takes up its full refrigerating effect in heat units. In actual practice, a refrigerant cannot take heat from any substance until the temperature of the refrigerant is lowered to a point at which heat will flow into it. This lowering of the refrigerant temperature from condensing to evaporating temperature is called liquid cooling. This cooling is accomplished by the evaporation of some part of the refrigerant that passes through the expansion valve.

So we must now determine how much Freon must be evaporated to cool sufficient liquid to insure removal of the actual total heat that constitutes the load.

After being properly cooled, the 218.5 lb. of Freon per hr. will carry away the heat that equals 1 ton of refrigerating capacity in 24 hr. From the following formula can be determined the per cent of refrigerant flowing into the evaporator used to cool the liquid,

$$\frac{h_1 - h_2}{H - h_2} = \text{per cent}$$

where:

h_1 is the heat content of the liquid at the temperature it leaves the condenser and passes into the evaporator.

h_2 is the heat content of the liquid after it passes into the evaporator and assumes the temperature of the saturated vapor in the evaporator.

H is the heat content of the saturated vapor in the evaporator.

Referring again to the tables and substituting the proper values, the per cent of refrigerant used for cooling is:

$$\frac{27.48 - 16.32}{82.38 - 16.32} = \frac{11.16}{66.06} = .1689 \text{ or } 17\%$$

This means that it requires 17% of the liquid that passes through the expansion valve for liquid cooling, and to provide a ton of useful refrigeration there must be circulated $\frac{218.5}{1.00 - 0.17} =$ 263.2 lb. of Freon per hr. Thus 44.7 lb. per hr. must be circulated to cool the refrigerant.

Then there are some impurities (oil, moisture and non-condensible gases) that are being circulated in all refrigerating systems. It is safe to allow 3% for such impurities. Then 103% of 263.2 equals 271 lb. of Freon that must be evaporated and circulated each hour to produce one actual ton of refrigerating capacity in 23 hr. This actual ton means the actual removal of the heat in useful work.

If operating conditions change, the amount of Freon circulated will also vary. In Freon-charged plants, the gain or loss caused by changed conditions is very noticeable due to the large amount of refrigerant circulated through the system.

In the tables it will be found that volume of the saturated vapor at 37 deg. is 0.833 cu.ft. per lb. Then in its saturated state the vapor circulated per hour, to produce 1 ton of refrigerating capacity in 24 hr. will occupy 271 × 0.833 or 225.5 cu.ft.

But vapor leaving the evaporator will usually be more or less superheated depending on the type of evaporator, length of suction line, insulation and type of compressor. In this problem a superheat of 10 deg. is assumed, which gives the gas a temperature of 47 deg. as it enters the compressors.

At 37 deg. the vapor has a gage pressure of 34.3 lb. Pressure remains the same as the 37-deg. vapor is superheated to 47 deg. and the volume per pound increases to 0.84 cu.ft. Then 271 × 0.84 = 227.6 cu.ft., which is the volume that must be compressed per ton of refrigeration. (It will be noticed that superheating of Freon vapor does not change the volume nearly as much as the same superheating affects ammonia.) As the heat to be removed is equal to 150 tons, the total volume to be handled by the compressor is 150 × 227.6 = 34,010 cu.ft. per hr.

The compressors cannot be expected to have better than 90% volumetric efficiency, so 10% or 3,401 cu.ft. must be added, giving a total of 37,411 cu.ft. per hour or 623.5 c.f.m.

As there are two compressors each will have a displacement of 311.8 c.f.m. At 257 r.p.m., the displacement per revolution will be 1.21 cu.ft. or 2090.88 cu.in. for each 2-cyl. compressor. Then each cylinder will have a displacement of 1,045.44 cu.in. per revolution. For this displacement the cylinders would be almost exactly 11 in. in diameter with an 11-in. stroke.

Actual amount of heat handled by the compressors is 271 lb. of Freon per ton × 54.9 × 150 = 2,222,297 B.t.u. Dividing by 12,000, the actual refrigerating capacity of the two units is 185 tons.

The actual capacity of the two 2-cyl. 11x11-in. compressors is 182.9 tons. This is 2 tons less than the exact requirements, but close enough to do the work satisfactorily.

New Boiler and New Piping Save 20%

Northampton (Mass.) State Hospital for Mental Diseases finds a centralized boiler plant saves money, even though buildings are scattered

By Edward C. Brown

Consulting Engineer

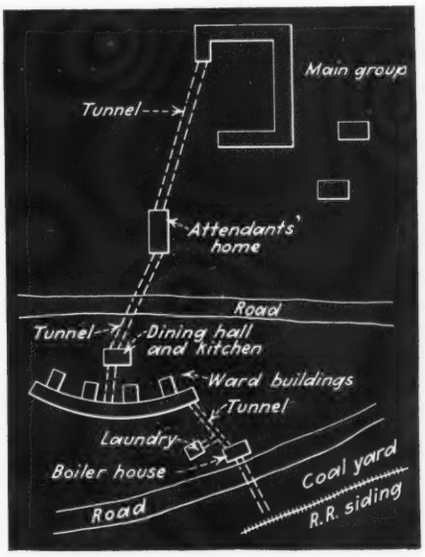
As told to Francis A. Westbrook

HEATING system efficiency was increased 20% at the Massachusetts State Hospital for Mental Diseases, Northampton, Mass., by a recent modernization program involving the construction of a new boiler plant and changes in the steam-distribution system. These improvements, made necessary by growth, have also overcome a number of problems peculiar to hospitals of this type. Labor formerly done by patients has been eliminated and transportation facilities between buildings improved.

Careful engineering was required in order to overcome the disadvantages of building arrangement. As shown in Fig. 1, the different units are scattered according to modern ideas of hospital management. A highway separates the main or older group from the ward buildings, kitchen, and laundry—all newer additions. Any future growth will probably be on this side of the road.

The main group of buildings was originally heated by three water-tube boilers and one h.r.t. unit, all hand-fired. As each of the ward buildings was built, two cast-iron boilers were installed, one to supply heating steam, the other hot water. This multiplicity of boiler rooms required an excessive number of attendants, much trucking and moving of coal and objectionable exposure of patients to all kinds of weather while engaged in handling coal. To avoid waste and inconvenience from this set-up, it was decided to build a central boiler plant as close as possible to the center of growth.

Fig. 1—Building layout and tunnel system



The new building houses three 3,330-sq.ft. low-head bent-tube Erie City boilers supplying steam at 200 lb. Space has also been provided for a future boiler and turbine room. Boilers are fired by Riley multiple-retort underfeed stokers driven individually by General Electric turbines and reducing gears. Settings are air-cooled, heated air being removed from the walls and supplied to stoker windboxes by forced-draft fans above the boilers.

Each unit has a Bailey boiler meter, Bailey draft gages, and a Brown CO_2 recorder. Combustion is regulated by the

Hagan system. Control is simplified by mounting instruments and controls on convenient panels on the firing floor.

Boiler feedwater is handled by three boiler-feed pumps. Two are centrifugal units, one driven by a motor, the other by a turbine. A reciprocating pump handles light loads. These pumps take their suction from a Worthington metering feedwater heater. Two steam-driven reciprocating vacuum pumps are used on the vacuum heating system of the hospital buildings. A turbine-driven centrifugal fire booster pump has been installed.

Mechanical coal handling has largely eliminated labor formerly done by patients. Coal delivered by rail is brought in on the siding in gondola cars, dumped into hoppers and then elevated with an apron conveyor to a central distribution pile. From this pile the coal is either moved into storage with a Sauerman drag-line scraper or is directed into a hopper feeding a single-roll crusher. Three Redler conveyors move the coal from the crusher to the boiler-house bunker. The first conveys it through a tunnel under the road between boiler house and coal yard, the second elevates it, and the third distributes it in the bunker. From the bunker, coal flows through clamshell gates into a traveling weigh larry, and after being weighed is delivered to the stoker hoppers.

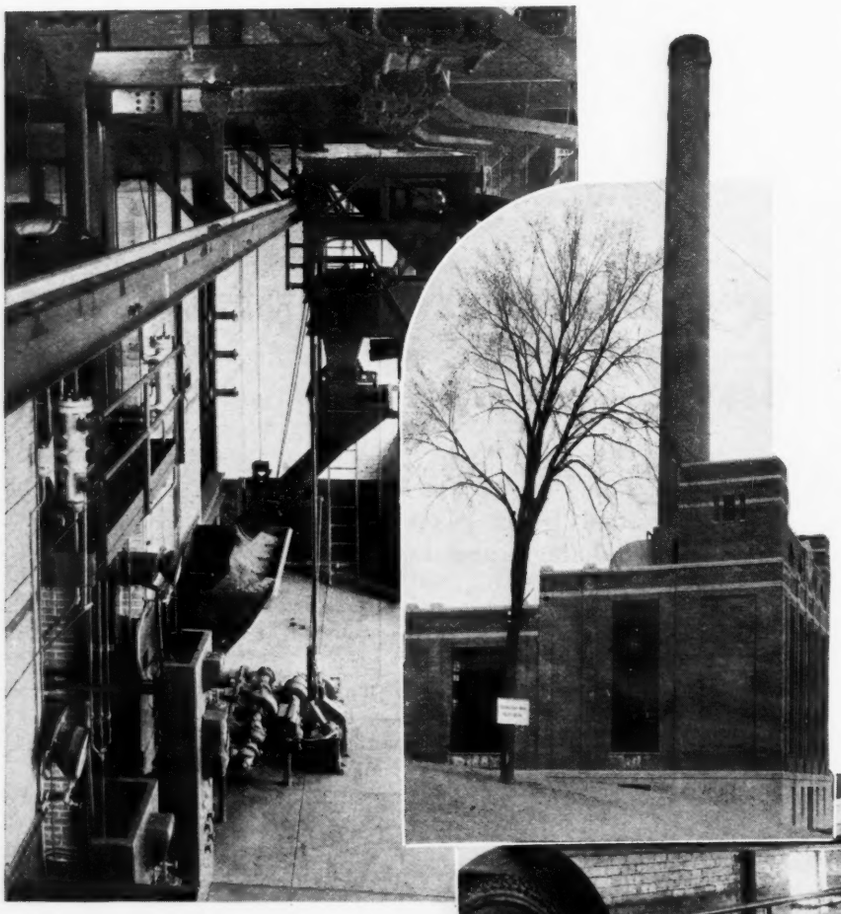
Ashes are quenched in boiler ash pits, dumped into handcars, weighed, then emptied into a skip hoist which elevates them to an outside storage hopper. From this hopper they are loaded into trucks and used on roads. An automatic push-button operated passenger elevator running between basement and coal-bunker platform is another refinement. The engineer keeps the key, however, to prevent its use by unaccompanied patients.

Steam is distributed to the different buildings in reinforced concrete tunnels that also serve as weatherproof passageways for patients. Welded piping with slip expansion joints is supported on one side wall. These lines are insulated with a double thickness of 85% magnesia and finished with a waterproof jacket. In addition to reducing condensation in the piping, this provides protection for people passing through the tunnels. Tunnels are comfortable all the year round, insulation and adequate ventilation maintaining moderate temperatures. The tunnel between dining hall and main group is wide enough for food carts.

Steam is reduced from 200 lb. to distribution pressures by reducing valves in the boiler plant. For the main group of buildings some distance away, pressure is lowered to 80 lb. for transmission through tunnels, then to 2-3 lb. by other reducing valves at the points of use. Steam for cooking and other miscellaneous uses is reduced from 80 lb. to 25 lb. Steam to ward buildings only 400 ft. away is reduced from 80 lb. to 4-8 lb. by reducing valves in the boiler plant.

Main reducing-valve stations in the boiler plant, 200 to 80 lb. and 80 to 4-8 lb., are composed of two reducing valves in parallel. One is large, the other small, and they are arranged that the smaller valve will operate on light loads, preventing chattering of the large valve. Both stations are controlled by Ruggles-Klingeman step-action regulators. Reducing valves proper are of the removable-cage chronometer type.

The new boiler plant and distribution system has greatly improved heating service in all parts of the hospital. The present operating force is three firemen and one relief fireman.



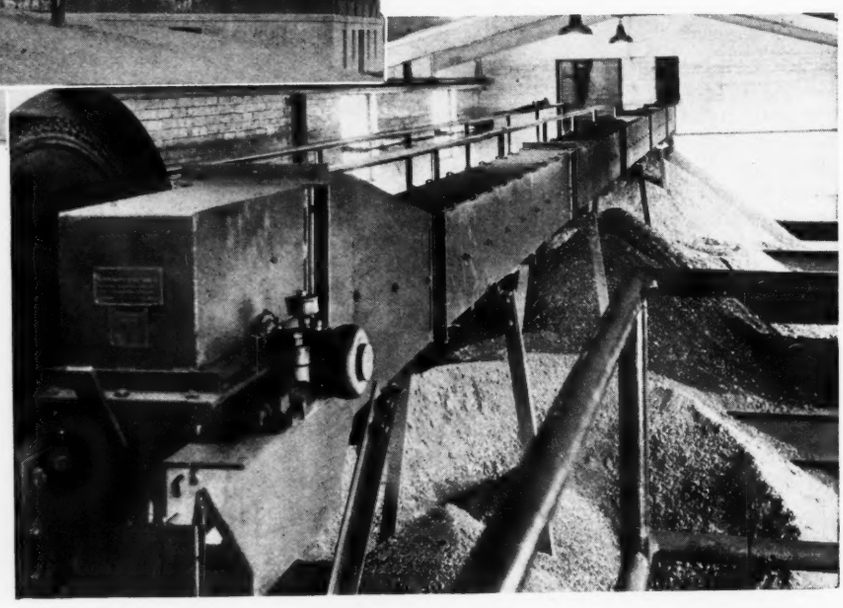
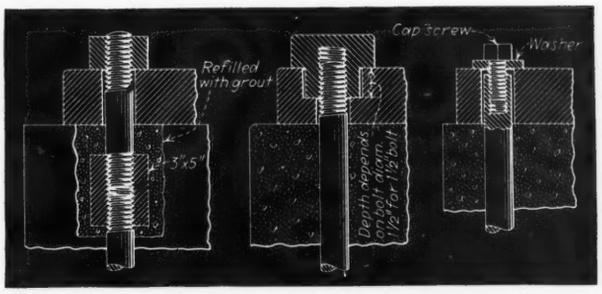


Fig. 2—The building has space for a future turbine

Fig. 3—Modern boilers and auxiliary equipment contribute toward a 20% fuel saving

Fig. 4——Mechanical coal-handling from car to bunker is the rule

PRACTICAL AIDS TO OPERATION



Method for Repairing Foundation Bolts

DIESEL-ENGINE foundation bolts rarely break, but when they do it is well to know how to repair them. The drawings show three different methods I have used to repair these bolts. In Fig. 1, grouting under the engine was in bad condition, therefore the engine was removed from its foundation and the concrete cut away from around the bolt. The bolt was then cut off 4 in. below the surface of the foundation with a short-blade hacksaw. This was rather slow, but cheaper than rebuilding the foundation. After the bolt was cut off, it was threaded by welding a die to a pipe coupling. A coupling sleeve was made for the bolt by drilling and tapping a short piece of shafting. With this, a threaded extension was connected to the bolt.

The design, Fig. 2, was used where the bolt broke just below the nut and when the grouting was good. In this case the engine bedplate was milled out around the bolt and a special capnut used. Fig. 3 shows another method, not as strong as Fig. 2, which should be used only where there are plenty of foundation bolts.

Good foundation material and a real grouting will hold the engine down without foundation bolts. Foundation bolts should be tightened only when the engine is being overhauled, at which time the crankshaft alignment should be checked to ascertain if the baseplate has been sprung by tightening the bolts.

Walthill, Neb. WM. W. DINGWALL

Blowing-Down Waterwall Headers

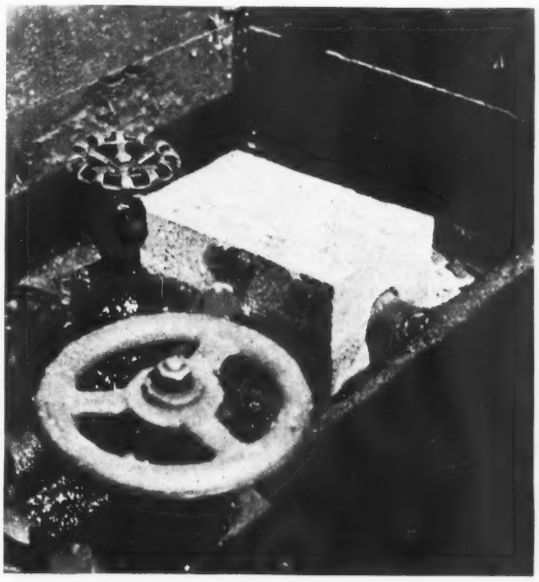
MANY high-capacity, medium- and high-pressure boilers have one or more waterwalls. Care in blowing down waterwall headers is necessary to avoid bulging or rupturing waterwall or slag-screen tubes.

Infrequent blowing-down may cause the header to become obstructed with loose scale or sludge. This restricts normal circulation, and causes water-starved tubes, steam pockets, and subsequent overheating.

Blowoff piping size in relation to the header diameter, and back-pressure on the piping have much to do with blowdown procedure. If the blowoff pipe is over 15% of header diameter, take care not to permit an excessive blowdown rate. The downcoming circulating tubes to the header are usually of a size that the blowoff pipe, if of large size, can carry away a considerable amount of the downcoming water. If the blowoff valve is opened for a reasonable time when boiler load is light, there is little chance of trouble. However, if the blowoff is opened for more than a brief interval when the boiler is operating at high ratings, with correspondingly high furnace temperatures, the riser or slag tubes fed from this part of the header may be seriously affected by the reduced circulation. Steam pockets form when water circulatory velocity from a steam-generating tube tends to be greater than the incoming feeder velocity. With high radiant temperatures, tube bulging and failure are likely to result.

High boiler ratings sweep sediment into suspended circulation, whereas with low ratings and circulation velocity, much of the sediment is precipitated into the mud-drum and headers. For these reasons, waterwall headers should be blown down when the boiler is operating at low ratings only. If for some abnormal operating condition these headers must be blown down during periods of high boiler rating, the blowdown time should be very brief.

Chicago, Ill. R. O. BILLINGS



Concrete Seals Pump Suction Line Leak

WHEN a 2-in. tee in a suction line handling a high-gravity crude oil was strained and distorted in installation all the usual methods of stopping the entry of air into the line were tried, but without success. Lead wool, calked into the ends of the fitting, soon worked loose under vibration; rubber sealing rings were affected by oil and either swelled or disintegrated and became useless; air would soon enter and the pump would kick off.

Finally it was decided to try concrete. A small form, extending some 6 in. each way from the axes of the fitting, was built and filled with grout. As the grout was puddled around the pipe, the pump was run, with all adit valves closed, so as to have sufficient suction at the break to insure that oil would not work outward into the concrete.

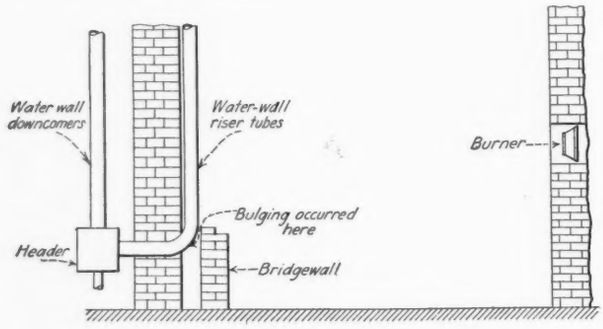
After the concrete had set, valves on the pump manifold were switched to make the normal suction line

serve as a discharge, and the maximum pump pressure, 100 lb. per sq.in., put on the former leak. There was no sign of oil seepage; and now, after being in service for over two years, the repair is as effective as when first made.

Longview, Texas — ELTON STERRETT

Bridge Wall Protects Waterwall Tube Bends

BULGING at the lower bends of waterwall tubes is not uncommon. It is the direct result of either flame impingement, localization of heat at this point, or unclean internal surfaces of the tubes. Even though burners may be adjusted correctly, retarded conductivity of radiant heat causes excessive temperatures in the tube bends. Unfortunately the lower bend in the waterwall tubes makes an ideal place for sludge or sediment to lodge. The boiler-drum surface and steam-generating tubes may be clean and practically free from scale due to feedwater treatment, when scale has lodged in the waterwall-tube bends. The absence of scale in the boiler is often an indication that the feedwater treatment is precipitating



the scale-forming solids as sludge. During operating periods of low load the circulation velocity through the waterwall tubes may not be sufficient to wash the bends free of sludge, which may then accumulate and bake on in a hard scale. With increased load, the heat release in the furnace causes overheating, bulging, or failure of the tubes at the bends.

It is sometimes advisable to construct a low bridge wall of firebrick to protect the tube bends from either flame impingement or direct radiant heat of the fire. Loss in effective radiant heating surface is negligible. Care should be exercised not to build the bridge wall higher than the top of the tube bends, or steam pockets may form in the tubes. The diagram shows an installation in a plant that had been bothered with this trouble. No further difficulties have been experienced since the bridge wall was installed.

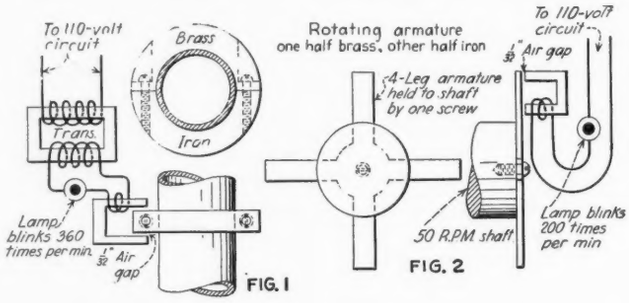
Chicago, Ill. — CHARLES A. ARMSTRONG

Signal Device Shows When Shaft Rotates

FREQUENTLY a signal device is required to indicate when motors are operating. The figures show a device which we have used for this purpose. A lamp is connected in series with a winding on an iron core having an air gap. For a speed of 42-r.p.m. and below a ring half brass and half iron is fastened around the rotor shaft (Fig. 1) so that it can revolve in the air gap of the iron core. This ring as it rotates alternately opens and closes the air gap. Closing the air gap with the iron section of the ring causes the lamp to go dim because of the increased inductance of the coil. When the brass section of the ring comes into the air gap the inductance of the coil is at a minimum and the lamp lights. Therefore as long as the shaft rotates the lamp will flicker.

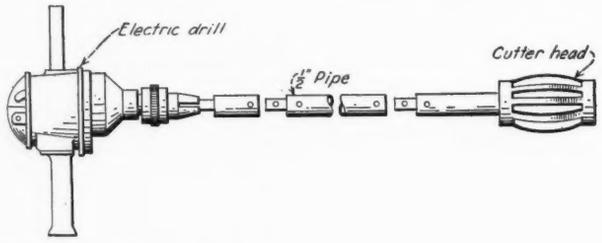
We have found this principle practical up to about seven blinks per second, or 420 r.p.m. of the shaft to which the ring is attached. For slow-speed shafts the arrangement of Fig. 2 is used. Here an iron ring is divided into four sections and attached to the end of the shaft. This will cause the lamp to give four blinks per revolution or $50 \times 4 = 200$ for a shaft running 50 r.p.m.

A laminated core for the coil is preferred, but is not



necessary. In general, for lamps up to 100 watts, the air gap in the core should be at least 1.5 in. long and the moving iron ring should have 1/32 in. clearance from the gap faces. About 1,000 turns of No. 20 magnet wire are wound on the core. Where 110-volt current is not available, a small transformer is connected into circuit, as in Fig. 1.

Corpus Christi, Texas — JOHN BOLTON, *Electrical Engineer, Southern Alkali Corp.*



Uses Electric Drill to Drive Tube Cleaner

WHEN vertical ammonia condenser tubes are cleaned, a cleaner operated by a portable electric drill worked very successfully with extension shafts on the cutter head. The top third of the tubes was cleaned first, then an extension shaft was connected to the cutter by a universal joint. After the middle third of the tube lengths was cleaned, a second extension was added to the cleaner and the job completed.

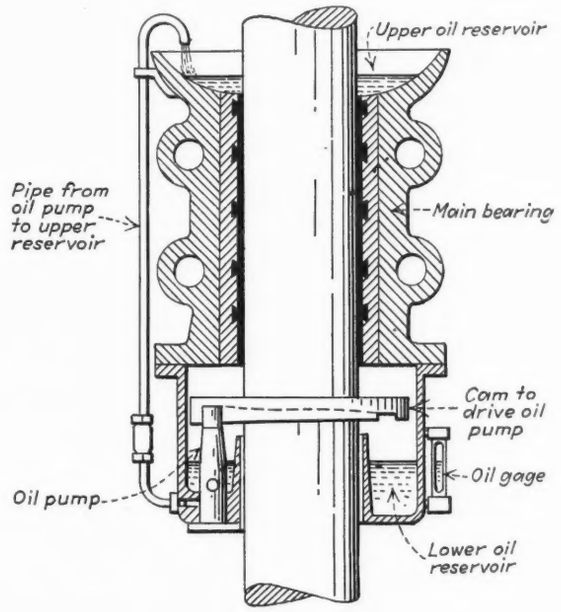
Extension shafts for the cleaner were made from ½-in. pipe with a cold-rolled steel stud riveted in one end and a hole to connect it to the free end of the stud in another section. A fitting was also made for the electrical drill so that it could be readily connected to the pipe. The extension shafts were easily connected in or removed as required, simply by inserting or removing a pin.

Cleveland, O. — FRED W. SCHNEIDER

Locates Mysterious Oil Leak

SEVERAL bearings on hydro-electric units operated successfully, but one lost oil for no apparent reason. All joints in the split bearing and lower oil reservoir were tested but no leaks could be found, so it was decided to dismantle the bearing to locate, if possible, where the oil was going. The diagram shows the construction of the bearing. As the oil comes from the bottom of the bearing, it strikes the oil-pump driving cam, which also acts as an oil thrower. Oil is deposited in the reservoir and returned to the top of the bearing by the cam-driven pump. It was found that the cam did not make a good fit on the shaft and allowed a small amount of oil to find its way down the shaft, where air currents removed it.

New York, N. Y. C. W. PETERS



Electric Heaters Keep Roller Gates Free of Ice

AS ROLLER gates in the dam on the Mississippi at Rock Island, Ill., are operated frequently to maintain constant water level in the pool above the dam, a method is required in winter to remove ice at all points of contact between the movable roller gates and the piers of the dam. Electric heaters have functioned satisfactorily and proved their reliability during the past two winters.

The roller gates are essentially structural-steel cylinders with both ends closed by steel-plate disks. Since the space between the disks and the pier masonry is subject to ice accumulation interfering with gate operation, electric heaters are attached to the inner surface of the end disks to heat the area where ice may adhere, as shown in the figures.

Each heater element is rated 3 or 4 kw. as required at 440-volts, and consists of a helical coil of resistor wire centrally embedded in a refractory insulating material (magnesium oxide) within a corrosion-resisting metal tube. Elements are generally similar to those commercially employed in ranges and immersion heaters, but are of larger dimensions and require features to insure hermetical sealing, since they must function in either water or ice.

The amount of heat to be provided was determined by consideration of the anticipated operating conditions and investigation of prior installations for the same purpose. Total heater capacity provided for each of the eleven roller gates is 42 kw., which has proved to be ample for all conditions encountered to date. 9 kw. are dissipated at each pier armature plate, and 12 kw. at each end-disk of the gate drums.

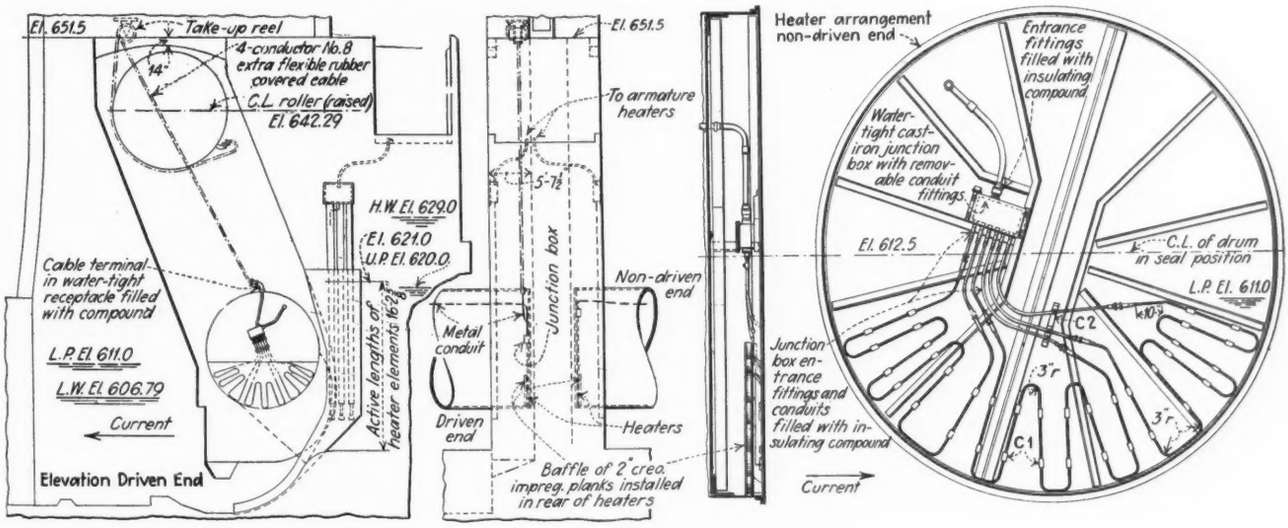
Davenport, Iowa A. D. MCEWEN
Westinghouse Elec. & Mfg. Co.

Uses Grease Gun to Lubricate Feed Pump

TO SUPPLEMENT the forced-fed lubricator on a boiler-feed pump, I recently tried an ordinary pressure grease gun with a fitting screwed into a tapped hole in the steam chest. There has been no leakage of steam outward through the fitting, it is more satisfactory than the hand oil pumps commonly used, less cumbersome, and cleaner.

Plain cylinder oil or a mixture of oil and powdered graphite can be readily fed at any time while the pump is in operation. Grease fittings can be placed in steam pipes to pumps and small engines and the grease gun used. I have never seen a grease gun used before for this particular purpose, and believe the idea worth passing along.

Worcester, Mass. A. M. LEADER



CURRENT COMMENT

How About Insulation-Resistance Tests

UPON reading the answers to Question No. 2 in the Nov., 1936, number, I was surprised to find that practically every answer omitted a very important feature of motor repair; namely, an insulation-resistance test. To clean the windings and then give the insulation a coat of varnish, before knowing what condition it may be in, is only courting future trouble. Any moisture in the insulation will be sealed in by the varnish and will cause a failure later.

After the winding has been cleaned, it should be baked until the insulation is thoroughly dry. This condition will be indicated when the insulation resistance becomes practically constant. Insulation resistance can be most conveniently determined by taking a reading with a megohm meter, designed for 500 volts. The insulation may be in such condition that no amount of baking will restore it to a safe condition. When this is the case, the machine should be rewound.

What a safe value of insulation is presents a question on which opinions vary. However, many maintenance and insurance engineers have adopted a standard of one megohm per 1,000 volts as a minimum value, for all machines designed for 1,000 volts and above. This means that a 2,300-volt machine must have an insulation resistance of at least $2{,}300 \div 1{,}000 = 2.3$ megohms, to be considered in safe operating condition. These standards also require that all machines operating on circuits of 100 to 1,000 volts must have a minimum insulation resistance of 1 megohm. In plants where these standards are maintained, unexpected electrical-equipment failures are practically unknown.

Practically all of the answers contained suggestions to blow the dust out of the motors with compressed air. Blowing dust from one place only to have it settle somewhere else seems like a useless effort. Why not use vacuum cleaning and remove the dirt once and for all? I know vacuum-cleaning systems have not come into as general use as compressed air. However, strong portable units are available that will remove practically all the dirt that can be blown out by compressed air. Even light portable machines can be obtained that will pick up a large part of the loose dirt, and their use is certainly preferable to blowing the dirt about. Vacuum cleaning also eliminates the danger of blowing moisture into the insulation, always present when using compressed air.

Lynchburg, Va. O. M. ROBERTS

KEEPING electric motors in good condition is a problem close to the heart of every engineer. The recommendations given in the answers to Question 2, November number, are very helpful but I would like to add further suggestions from my own experience. Methods, frequency and kind of cleaning used depends upon type, age and condition of the insulation, amount of oil leakage, atmospheric conditions, location and type of motors.

Good maintenance practice calls for a periodic routine inspection schedule, rigidly followed. How frequently the inspections should be made depends upon operating and other conditions, but, they should be made frequently enough to insure detecting and correcting detrimental conditions before they have time to cause trouble. A report should be made of all inspections and a record kept of all important data. This will permit a study of motor conditions and inspection schedules can be arranged accordingly.

Open-type motors located in dusty and dirty areas should be blown out daily, either with a hand bellows or with compressed air. When the latter is used, care must be taken to insure moisture-free air or it may be injurious to the insulation. Motors in continuous service under normal conditions should be throughly cleaned at least every six months.

Oil leakage from sleeve bearings into motor windings is the most frequent cause of insulation failures and difficult to prevent unless the bearings are properly designed to keep oil from flowing out along the shaft. Such bearings should be sealed with felt to prevent air currents from carrying oil vapors out of the bearing housings onto the windings. The cleaning, drying and insulating processes were thoroughly covered in November answers, and require no further comment.

Waynesboro, Va. J. M. MYERS.

High-Speed Steam Engine

I HAVE read with much interest P. W. Swain's thoughts concerning further possibilities for steam engines in August, 1936, *Power*.

If we are talking about a reciprocating steam engine of say 300 hp. or even 600 hp., for a manufacturing plant or a hotel, the very first requisite is "reliability." It must run, or else you must have complete "standby," and up goes the capital investment for extra engine sets.

I do not believe that very high piston speeds are in the picture for a manufacturing-plant steam engine. What may be true for a gasoline engine or a diesel is not true for a reciprocating steam engine. The automobile gasoline engine we count out after 70,000 miles or so. A diesel, it is my belief, would have to be very much rebuilt after 6 or 7 yrs., and takes a lot of looking after during that time. Our steam engine at Middleboro has run for over 30 yr. without the loss of an hour's work, and the upkeep spread over its life has been almost nothing. A well-designed and well-built reciprocating steam engine, over a term of 30 yrs., as far as I know, has no competitor. A turbine, yes, but I am considering small powers up to 600 hp.

Mr. Swain said "uniflow of course." I am not so sure even about that. I like a uniflow, but actually it is only at its best as a condensing engine. If you use exhaust steam at 3-lb. pressure, the uniflow at best is only a "twoflow," not a uniflow.

If you have to use 3-lb. backpressure, you can take a counterflow, and if it is designed correctly and there is plenty of superheat, you can equal a uniflow's steam economy. At 200 r.p.m. cylinders and valves, after they are properly warmed up, take on a more or less uniform temperature. There simply is not time for the heat exchanges that theoretically are supposed to take place. On the old slow-speed pumping engine, yes, but not at 200 r.p.m.

If I could do my own picking for a 600-hp. engine, I would use a counterflow at 250 lb. pressure, 250 deg. superheat, 200 r.p.m., with cylinder diameter to stroke correct, very small cylinder clearance volume, small valve and long valve travel, and late compression.

And the interesting point is this: you do not have to make any radical changes. It has been proven again and again that the best all-around steam economy is obtained with 25 to 30% cutoff, that steam flows should be kept within certain limits, that steam ports should be very fully opened, and that the cylinder clearance volume should be the very minimum and yet have just enough compression.

I have seen these rules worked out in two different cases: one in U.S.A., one in France, one with single expansion, one with compound, both non-condensing, both operating at 250 lb. pressure, 250 deg. superheat, both 3,000 hp. at about 300 r.p.m., and the steam consumptions almost alike; the single expansion 13 lb. steam per cyl. hp., the compound engine 11½ lb. steam per cyl. hp.

The single expansion was an engine of the utmost simplicity and fewest possible parts. In fact it would hardly be possible to use less parts. Why talk "uniflow" or 1,800 r.p.m. when you can get the above performance?

One more point, if I may make it. Suppose the steam engine is limited to 200 r.p.m. (as it should be), is it so old-fashioned to go back and use a belted generator to run at 900 r.p.m.? That means a smaller generator and a cheaper one, and a belt, but it will run for a good many years and usually most plants can find the space for a small belted generator.

Mr. Swain's comments were interesting, although I do not believe that a steam engine can be abused that way. It can be done, but then what?

Campello, Brockton, Mass. N. A. CAMPBELL

Why Bite the Hand That's Feeding You?

AFTER reading the editorial "Average Plant —Big Job" in November, 1936, *Power*, I could not help but think of an incident that happened to me in an industrial plant where I became engineer. This plant was only 4 yr. old, but it was worn out. I went to work to put the plant back in efficient working condition. And after working like a horse for 2 yr., I had things back in shape so that I could look around to see what could be done to save coal.

I drew up a sketch and took it to the assistant manager, who saw the point right away and told me to go ahead. I used a mason for one day and a carpenter for half a day. After the job was finished and we had put the scheme in operation, the saving amounted to just 5 tons of coal a day. My salary did not cost the company anything thereafter, considering coal at a fair price of $6.50 a ton. The records

showed this saving, but nothing was ever said about it. A short time later, business became slack and I was laid off. The company doubled up on jobs, making one man do two jobs, I found out later.

You certainly hit the nail on the head when you said, "The quickest way we know to pick up some easy profits in the typical factory, institution or large building, is to hire a first-class engineer, pay him an adequate salary, give him ample authority to make improvements, then hold him responsible for the dollar results." But when he makes a saving, why jump on his neck?

West Haven, Conn. BILL JONES

A White-Collared Boiler Inspector

NOT forgetting the seriousness of laxity in boiler inspection, a rather amusing incident occurred recently in a large municipality of an eastern state. The state had a highly-developed and well-enforced boiler code, following the standards of the A.S.M.E. This particular city was exempt from state boiler inspections and rulings, as it has its own boiler-inspection department. One of the principal activities of this department was to make an annual hydrostatic test of each boiler within its jurisdiction. Internal inspections were seldom made if no leakage showed on the hydrostatic test.

A notice was received by the owner of a water-tube boiler stating that the local inspection would be made on a certain date.

Afterward, the owner received word from his engineer that a nipple had sprung a leak under the pressure test, and had squirted a considerable amount of rusty water around. Strange to say, shortly thereafter the owner received a bill for $15 from the boiler inspector. The bill was for a new white shirt, a new light grey felt hat, new silk necktie, and the cleaning of a business suit.

Boston, Mass. C. O. DIBBLE

READERS' PROBLEMS

QUESTIONS for Our Readers

Feed Water Heater

Question 2

IN OUR PLANT *we have a large dearating feedwater heater with a vent condenser designed for an inlet-water temperature of 60 deg. F. In our case, however, water enters the heater at 190 deg. F. A great deal of steam seems to be wasted through the atmospheric escape pipe of the vent condenser. Can we reduce this loss by putting a thermostatic air valve in this line? What is the best way of controlling the temperature in this heater? Should we use a pressure- or temperature-controlled makeup steam valve, and if so, where should the pressure control line or temperature-control actuating bulb be located?*—J. P. C.

Condenser Changes

Question 2

OUR *double-pipe ammonia condenser is on the roof in a very exposed place. It freezes every year as soon as we get zero weather. Could we run it as an atmospheric condenser during the winter, without making any changes except running the water on the outside of the pipe? The condenser has seven stands 18 ft. long, 12 pipes high. Outside pipes are 2 in. in diameter, and the inside pipe is 1¼ in. About what capacity can we expect, if used as an atmospheric condenser?*—E. M.

Suitable answers from readers will be paid for if space is available for publication.

MAKING BELTS LIVE LONGER

ANSWERS to November Question 1

The Question

SINCE *starting up our new plant we have experienced what we consider short belt life. I shall appreciate it if POWER readers would tell me what are some of the factors that might cause this condition.*—B.E.N.

Recommends Good Belt Dressing

SOME REASONS for short belt life are overloading, operating a leather belt with the flesh side on the pulleys, too much or too little tension, and pulleys not properly aligned. I always make it a practice to operate leather belts with the hair side on the pulleys and, wherever possible, to run the belt with the slack side on top, with splices pointing so that they will tend to close, and not roll open. I also use a good belt dressing applied with a brush once a month to both sides of the belt.

Oelwein, Iowa JAMES A. WELCH

Recommends Large-Diameter Pulleys

ASSUMING that the common causes of short belt life have been eliminated, it is also important that the pulleys have proper crowning, are in good alignment, that the machine and driving units set level and the ends of the belt properly squared before lacing. If frequent take-ups are required to keep a belt from slipping, it is an indication of overloading. When selecting pulleys, use as large diameter as possible without causing excessive speed. Bending a belt around small-diameter pulleys is detrimental to its life. A belt should not operate at a speed above 5,000 ft. per min. Best practice is around 4,000 ft. per min.

St. Marys, Ohio J. L. YOUNG

Make Recommendations for Multiple V-Belts

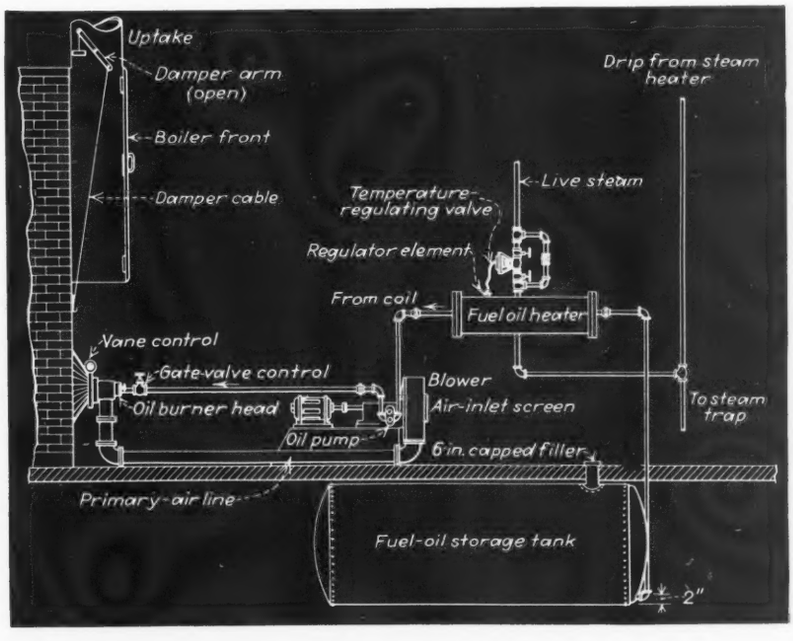
NO MENTION is made in the question whether V-belts or flat belts for power transmission or conveyor belting, etc., are referred to. Short V-belt life can be traced to flexing over too-small diameter pulleys, overload causing slippage or stretch, and atmospheric conditions separating belt plys, especially in case of raw-edge cut belting. Often the correct service factor is not taken into consideration, such as shock loads, high starting duty, and if operation is to be 10 hr. or 24 hr. per day.

In multiple-groove pulleys, it is important to have identical grooves, otherwise

WHAT'S WRONG WITH THIS PICTURE?—XI

Mechanical-Atomizing Oil-Burning Equipment

There are at least 26 mistakes shown in this drawing. Make a list of those you recognize, then check against the list on page 50



pitch diameters are not the same and each belt will tend to run at a different speed and cause short life. Too few belts cause slippage and excessive stretch. Flexing around too-small diameter pulleys will cause short life of any type of belting.

Rittman, O. U. J. GRANT

How to Obtain Long Belt Life

TO OBTAIN long belt life, use a good grade of belting on properly designed drives and operate belts endless when possible. Put all belts in charge of one man and make it his duty to examine them at regular intervals for proper tension, condition of the belting material, splices or lacing. He should also be required to keep a detailed record of each belt, showing the date installed and repairs made during its life.

Causes of short belt life are excessive moisture, acid and other fumes, high temperatures, oily conditions, pulley too small for the belt thickness, overloads requiring excessive tension in the belt or causing serious slipping on the pulleys, improperly designed pulleys and friction between belt edge and a stationary object.

Belts operating in oily conditions should be removed periodically and soaked in gasoline or naphtha. After the oil has been removed, treat the belts with a good dressing. Large speed changes, idler drives mule pulleys and other types are often inherently hard on belts and must be taken into account when considering belt life.

Milwaukee, Wis.
LAWRENCE M. LARSON

Selecting Belts

WHEN CALCULATING the size of a belt required for a given drive, peak-load and starting-torque conditions should be considered, not the capacity of the driving unit. The former may be considerably in excess of the latter and if not given proper attention, serious overloading of a belt may result. When starting by connecting a motor directly across the line, or when starting a high-friction or high-inertia load with a wound-rotor motor, a starting torque equivalent to two or three times running torque may be developed. If a belt is selected for these conditions on a basis of normal-load requirements, it will be seriously overloaded during starting periods and may slip and burn.

If equipment is driven from lineshafts, belt calculations should be based on the starting and running torque needed for machines connected to each shaft. When belts are selected of ample capacity and are given reasonable care, they should give long and satisfactory service.

The power-transmitting capacity of belts depend upon their speed and coefficient of friction between them and the pulleys. Wherever possible, belts should be operated slack with the slack side on top to increase the arc of contact with the pulleys. When belts are operated tight, they make a minimum arc of contact with the pulleys and the excessive tension reduces both belt life and power-transmission capacity. Long belts with the slack side on top will frequently operate satisfactorily with considerable slack and have greater power-transmitting capacity than when tight.

Woodbury, N. J. R. W. CARTER

Properly Align the Shafting and Pulleys

OF THE MANY factors that contribute to short belt life, forcing belts to run upon pulleys that are out of alignment is one of the worst, as frequently one edge of the belt rubs continually against some obstruction to keep it on the pulleys. Under such conditions, excessive wear occurs along one edge of the belt, soon the laps begin to open, which is the beginning of the end. Pulleys and shafts should be in good alignment.

There is a tendency to over-tighten belts in an effort to make them deliver more power. This shortens their life by robbing them of resiliency. Run belts relatively slack, and keep them pliable by judicious use of a suitable belt dressing.

Another factor contributing to short belt life is using double-ply where single-ply construction should be used. When belts run over small-diameter pulleys, they are flexed through such a small-radius arc that buckling results, which tends to cause early failure if they are of double-ply.

Dust settling on running belts will abrade them when it is carried in between belt and pulley. Anything which tends to cause excessive slipping of belts will cause excessive wear. Other factors tend to shorten belt life, but those mentioned are responsible for the great majority of trouble.

Peoria, Ill. JOHN E. HYLER

Slow Speed of Compressor Caused Trouble

THE LIFE of a belt depends more upon total load than upon any other condition. Double-leather belts, when treated with care and run night and day at moderate speed, should last for 7 years when under average total load of 111-lb. per in. width, or 358 lb. per sq.in. section. They should last for 18 yr., when under average total load of 54 lb. per in. of width, 174 lb. per sq.in. section.

The distance between shafts has much to do with the length of belt life. The closer together the pulleys, the greater number of times the belt must come in contact with them, therefore the greater the number of times a given belt section is bent around the pulleys. Of course, there are other causes of short belt life, such as rough pulley surfaces, acid fumes, harmful belt dressings, and improper machinery speed.

I was once called on a trouble job where belts wore out rapidly. I found the idler pulley hammering at a rapid rate and rupturing the belt. Analysis showed that the belt had ample capacity for the power transmitted. I found, however, that the compressor was operating below the speed for which it was designed. Under this condition the flywheel effect was not sufficient, resulting in excessive load fluctuation and rapid hammering of the belt by the heavy idler. When speed was corrected, the idler ran smoothly and premature belt breakage ceased.

Atlantic Highlands, N. J.
M. M. GOOCH

Give Belting a Square Deal

LEATHER belts put into service for the first time are frequently subjected to unfair treatment by being expected to require little or no attention for a long time. A new belt may have been in the stock room for some time under atmospheric conditions tending to dry out the original dressing and reduce pliability. When this is the case, the belt structure fails rapidly under operation if not properly treated.

After a few days of service, a new belt should be dressed liberally on the outside with neatsfoot oil and castor oil mixed in equal parts. Relieve all tension in the belt and apply the mixture with a brush or a rag. Allow the oil to penetrate over night or a week-end and after a few such applications, the treatment will not be necessary again for months.

Other contributing factors to belt failure are: overload, dirt, pulleys out of line, improper splicing, insufficient surface contact and lack of crown on pulleys. Much harm can be done by sprinkling resin on the driving side of a belt, which makes an ideal dust and dirt collector.

If possible, a few spare belts should be kept on hand so that when one shows signs of distress, it can be immediately taken out of service for proper treatment.

Kearny, N. J. GEO. MCNALLY

HOW TO END DIESEL EXHAUST NOISE

ANSWERS to November Question 2

The Question

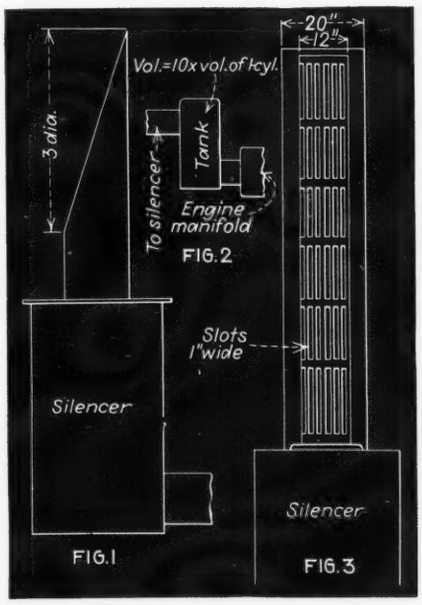
WE HAVE *two large 8-cyl. diesels driving centrifugal pumps through right-angle drives. Though of different makes, each has an exhaust manifold along one side, running directly into an 8-in. welded-steel pipe which right-angles outside the building through a muffler. One engine runs quietly, the other has a pulsing exhaust note that can be heard for a mile or more. Both engines run smoothly and create no vibration. What are possible causes of the noise, and can POWER readers suggest remedies?*—C.V.C.

Three Methods

THIS is a job for a trained engineer. My advice would be to call in an engineer from a silencer manufacturing company. He can recommend the proper silencer and correct way to install it.

The discharge of the exhaust of an engine sets up sound waves in the air similar to those set up on the surface of a pond when a stone is tossed into the water. The bigger the stone, the larger the waves. The same is true of the exhaust—the higher the pressure of the exhaust wave at release from the stack the louder the noise.

Silencers are built to reduce this wave by expanding the exhaust gases and cooling them. Tests have proved that there are correct lengths and sizes of lines for each engine. The line should be of such a length that the wave will be at its lowest point when it is released into the air. If the line is too short it does not have time to reduce to this point, and if the line is too long it will build up again and cause noise.



If C.V.C. wishes to experiment he could try some of the methods above. These work in some cases and not in others. One way is to cut the exhaust stack on an angle as shown in Fig. 1. A second way is to use an old tank with a volume 10 times that of one cylinder. This should be placed near the manifold of the engine, and the exhaust line run from it to the silencer, as in Fig. 2. A third way is to slot the present exhaust stack on the muffler and put a larger pipe around it, as in Fig. 3.

Walthill, Neb. WM. W. DINGWALL

Don't Muffle; Correct

THE fault lies not with the engine but with the exhaust system and is not readily taken care of in design because of the large number of variables involved.

When the diesel approaches the end of its power stroke the cylinder pressure is commonly above atmospheric. As the exhaust is liberated, either by valve opening or port exposure, a surge of compressed gas travels along the exhaust line. Assuming exhaust temperature to be about 400 deg., this wave of compression will travel along the exhaust line at a rate of about 1,350 f.p.s. (This speed is a function of the exhaust temperature).

When the open end of the exhaust line is reached, a portion of the wave will be reflected back toward the engi , where it will once more be reflec . Suppose that just as the wave is reflected at the engine another expansion stroke is completed. This new exhaust discharge causes a new wave of compression which is added to what is left of the old one, causing a high compression surge to travel down the line. Now if each of these successive surges were allowed to die out, it would quickly do so, but the added impulse which the wave receives each time it returns to the engine not only maintains it but tends to increase its intensity above its original value.

The portion of the compression wave that is not reflected at the open end of the line creates an atmospheric disturbance which we recognize as sound. The pitch of the sound will depend on the frequency with which these impulses are emitted, and the quality of the sound will depend on their uniformity. Since the exhaust gases have turbulence when they leave the engine and since turbulence may be increased by the form of the exhaust line, there will be a complete lack of uniformity among the pulses emitted and the exhaust will be noisy.

The reason for C.V.C.'s trouble is that for the engine with the noisy exhaust the length of the exhaust pipe is just right to cause the "building up" action described above. The quiet exhaust engine is quiet because this "building up" action does not take place in its exhaust line.

The cure is simple. If the exhaust line of the noisy engine is lengthened, then the noise can very probably be eliminated. The proper length can be determined best by experiment. A good starting point would be to make the noisy exhaust pipe the same length as the quiet one, if possible, provided both engines run at the same speed.

In my opinion, attempting to muffle this exhaust by sound-absorbing means is the wrong thing to do. It is not only an expensive method if it works but there is also the additional fact that if the original condition is allowed to exist the engine is not doing its best, for if the exhaust valve is open when the wave of compression returns to the engine, then the backpressure of the engine is increased.

Bronxville, N. Y. V. P. RADER

Two Suggestions

C.V.C.'s experience is not an isolated case, as most diesel erectors have occasional trouble with noise. My experience is that the problem hinges on engine speed. Exhaust pulsations synchronize with a multiple or derivative of the speed of sound, and a loud exhaust noise results. And, incidentally, 8-in. exhaust pipe has caused the most trouble.

On one job, before noise could be eliminated, $200 worth of windows were broken. An 8-in., 16-gage round pipe had been buried in a trench 46 ft. long, connected on one end to a 7½-in. line on the manifold, and run to a right-angled pot muffler of 4 cu.ft. capacity. When the engine was put into operation, windows broke.

We then dug a pit, 4 ft. square and 6 ft. deep, placed the pot muffler in the bottom, and allowed it to exhaust into the pit. To carry gas away, we covered the pit with a piece of boiler plate, cut a hole for a 7-in. x 12-ft. pipe, and bolted it to the plate by a flange. This made an almost noiseless job.

Another way of dampening exhaust noise is to insert a 6-ft. length of larger-diameter pipe midway in the exhaust line. A loosely-rolled piece of poultry netting inside the 6-ft. length will break up pulsations and lessen noise.

I have found that observance of the following precautions has successfully lessened noise troubles. For exhaust lines 12 ft. long or over, never use a size that is a multiple or derivative of valve or manifold outlet size, i.e., use 7-in. exhaust pipe with a 4-in. manifold, not 6-in. pipe. And never allow exhaust gas to attain a speed in ft. per sec. that will divide into 1092 (the speed of sound), or a multiple thereof. If the engine is designed with integral exhaust line, break up pulsations by altering the size of the exhaust pipe as near as possible to the engine.

Toronto, Ont. GEO. H. HOYLES

Exhaust-Line Length Wrong

LENGTH of the exhaust line on the noisy engine is apparently just right so that one exhaust impulse collides with a rebounding portion of a preceding impulse and both emerge together with an increased intensity of sound. If the noisy engine were exhausting through an independent exhaust line with a suitable muffler, the excessive noise would probably not be present.

A simple but effective exhaust muffler can easily be constructed of an oversize pipe with a size smaller pipe 8 to 10 ft. long in the discharge end, closing the space between the outer ends with flanges. The space between pipes provides a cushion which will dampen the exhaust impulses if the center pipe is of the correct length, otherwise it may build up and increase the noise. Proper length is determined by trial.

Irregularities in shape or size of the pipe or manifold may cause a retarding of the impulses so the line becomes a resonator for the engine exhaust.

Lexington, Ky. IRA A. BUTCHER

Call In A Specialist

SUPPRESSION of exhaust noise on any internal-combustion engine is an extremely difficult job involving the application of applied physics and sound. The best procedure in this particular case, and based on my actual past experience, would be to call in the Maxim Silencer people who are apparently the only ones in this country that have the necessary technical knowledge of the problem and the necessary instrument equipment to determine just what the causes are.

In a somewhat similar situation we called in Maxim, and by means of a microphone on the power-station roof, exhaust noise was picked up and put through a harmonic analyzer by which the various sound components were weighed and the frequency determined. In general it is the low-frequency notes below sixty cycles which cause the greatest amount of complaint, and in cases windows are rattled by a 20-cycle which is inaudible to most ears, but carries a tremendous amount of mechanical power.

Another possible angle to the question is that if the two engines are not operating at exactly the same speeds, they tend to drift by each other producing a heterodyne note.

Cedar Rapids, Ia. JOHN M. DRABELLE
Mechanical & Electrical Engr.
Iowa Electric & Power Co.

Use An Indicator

IT WOULD be well to analyze indicator cards taken under full load. More than likely a sudden drop in pressure will be found at the point in the expansion curve where the exhaust valve opens. This would not necessarily make the engine run roughly or vibrate. It would, however, produce explosive effects in the exhaust system. To remedy this, first see that fuel is injected into the cylinders at the proper time. Granted this is correct, it may be that combustion is poor, usually caused by poor atomization. This would allow combustion to continue too long. Next check the exhaust- and inlet-valve timing with the valve-timing diagram from the engine man-

ufacturer. Also check valve, tappet and roller clearances.

If the exhaust valve opens too soon, it would naturally allow the gases to escape with explosive violence, making the exhaust noisy. This will be clearly seen on an indicator diagram.

Also investigate the possibility of the cylinders getting too much lubricating oil, which finds its way into the combustion chamber, furnishing fuel which burns late in the cycle. This could be suspected if oil consumption is excessive.

Finally, consider the possibility of a state of resonance with the exhaust note existing in the piping and muffler system. This condition might be remedied by changing the length of pipe or introducing an auxiliary air chamber into the exhaust line.

Chillicothe, Mo. LOUIS N. WEAVER

Spiral In Exhaust

IN ONE instance where a hospital was erected adjacent to an already operating diesel-powered pipeline pumping station, it was found that insertion of a spiral, made of 1¼x1¼-in. angle iron, within the 8-in. exhaust pipe for the last 6 ft. of its length—the spiral having 1½ turns in that distance—imparted a swirling motion to the exhaust.

Slotting the exhaust pipe longitudinally with a cutting torch for a foot or so near the end—leaving a 6-in. band of metal uncut—allows exhaust to bleed through to air slightly and thus reduce the impact at the pipe end. These slots also permit air to *enter* the exhaust pipe behind the separate puffs of exhaust gas.

Longview, Texas ELTON STERRETT

WHAT'S WRONG WITH THIS PICTURE?—XI

Mechanical-Atomizing Oil-Burning System—See Page 47

THESE errors are those commonly found in oil-burning installations. The errors are restricted to the oil-burning equipment, and to such mistakes as are directly influenced by this equipment.

1. *Fuel-Oil Heater is in Wrong Place.* High-temperature fuel-oil heaters should be between oil pump and burner.

2. *Temperature-Regulating Valve Element is in Wrong Place.* Regulator element should operate according to the temperature of fuel oil flowing from the heater. As shown, it would act on the temperature of steam or condensate surrounding the coil.

3. *Fuel-Oil Heater Drip Connected Wrong.* The condensate drip line from regulator-controlled heaters should be independent of all other steam drips. As shown, steam might back up from the header drip into the heating coil after the oil was already at a high temperature. The temperature regulator would close, but steam backing up into the coils would cause a still higher temperature. Excessive pressure would result in the element line, and probably a ruptured diaphragm or bent regulator spindle.

4. *No Check or Stop Valve on Heater Drip Line.* Even though the heater drip line is connected to an independent trap, a stop valve or a check valve is desirable in the line. Repairs to the heater should be possible without danger of steam leaking back through the trap.

5. *No Relief Valve Protecting Fuel-Oil Heater.* When the heater is placed in proper position in relation to the pump, the heater must be protected from overpressure by a relief valve on the oil piping. Relief-valve discharge should be piped back to the storage tank.

6. *No Visible Drip from Fuel-Oil Heater.* When condensate from a fuel-oil heater is reclaimed for boiler feed, it is always advisable to provide a visible drip. This may be done by substituting a tee for the elbow in the condensate drain line, and connecting a nipple and globe valve. Periodically, a sample of the condensate should be drawn from this valve in a clean container. Examination of the sample will indicate whether there is any oil in the condensate; as there will be if the coil is defective. It is better to make the discovery this way, rather than wait for the results of fuel oil in a boiler.

7. *No Thermometer in Oil Lines.* Proper oil temperature is an important factor for good combustion. A thermometer should be provided in the oil piping at the entrance to and at the outlet from the heater, otherwise the effectiveness of the heater, and the operation of the burner would be a matter of guesswork.

8. *No Heater Coil in Storage Tank.* A steam coil is usually necessary to heat the contents of underground fuel-oil storage tanks. In winter months, the viscosity would be too high to permit proper flow to the pump suction.

9. *No Auxiliary Fuel-Oil Heater.* An auxiliary oil heater is usually provided to start the plant when there is no steam pressure. An electric heater, between the pump and the burner, maintains proper temperature for combustion until steam pressure is raised. When sufficient steam temperature to operate the regular oil heater is available, the auxiliary heater is cut out.

10. *No Oil-Pressure Governor.* A suitable pressure governor should be provided at the pump discharge, so that a constant pressure may be available for burner control.

11. *No Oil-Pressure Regulator.* Unless steam demand is practically constant, it is almost impossible to maintain constant steam pressure with good combustion by hand control. A steam-pressure operated, oil-pressure-regulating valve is desirable in the burner connection.

12. *No Pressure Gage in Oil Piping.* A pressure gage should be provided at the oil pump discharge, and at the burner. Absence of these gages makes pump operation an unknown factor.

13. *No Strainer in Oil Piping.* Fine-mesh, twin strainers are essential for proper and continuous operation. They should be in the oil-pump suction piping, near the pump, and in the discharge from the heaters.

14. *No Return-Oil Circulating Line.* Oil-pump discharge piping should extend, full size, past all burners and back into the return line to the storage tank. A stop valve should be in this line just after the last burner. In starting up, this valve is opened until warm oil is pumped through the circulating system. Then the valve is closed and warm oil is available at the burners.

15. *No Cushion Chamber in Pump Discharge.* An air-cushion chamber is usually advisable in the discharge line of a rotary oil pump. Pulsations may cause a distinct fluctuation of the flame if they are not dampened or smoothed out.

16. *No Manhole on Storage Tank.* A manhole is necessary as an entrance to clean, inspect or repair the tank. Furthermore, it would be impossible to build a riveted tank with convex heads and no manhole.

17. *No Sounding Opening in Storage Tank.* An opening for a sounding rod or tank gage is necessary to check oil level.

18. *No Vent on Storage Tank.* A vent, at least 2 in. in diameter, should be provided at the highest point of the tank. This allows escape of air and gas when the tank is being filled or heated. Otherwise, a dangerous pressure would build up and cause unstable operation.

19. *Pump Suction Line Too Near Storage Tank Bottom.* Minimum distance advisable between the oil pump suction and the bottom of the storage tank is 6 in. If the suction line is below this, sludge and water may be drawn in. Many operating difficulties would then result. Suction line should enter through top of tank, thus eliminating danger of draining the tank through a leak in the suction piping.

20. *No Water Connection in Storage Tank.* A pipe connection should be made to within about 3 in. of the storage-tank bottom. Periodically, accumulated water should be pumped from the tank through this line. Piping and valves may be arranged to use the regular oil pump for this when the plant is shut down.

21. *No Primary-Air Regulation.* A butterfly valve or damper should be provided in the primary-air duct so that adjustments may be made to meet combustion conditions.

22. *Gate Valve Gives Too Coarse Control of Oil Flow.* A needle valve or "chronometer" valve is necessary to give fine adjustment in oil flow to the burner.

23. *Damper in Uptake Improperly Connected.* As shown, a broken damper cable would allow the damper to close. This is a dangerous condition in an oil burner, and a flareback might easily result. The damper should be connected so that failure of any cable or link would cause it to remain open or stationary but not to close.

24. *No Primary-Air Indicator.* A manometer or some type of air-pressure indicator is desirable on the primary-air line at the burner. Otherwise, definite knowledge of desired primary-air adjustment would be impossible.

25. *No Meter in Oil Line to Burners.* To keep a record of oil consumption, it is customary to install an oil meter after the oil heaters. The meter should be bypassed.

26. *No Valves at Suction and Discharge of Heater and Pump.* Pumps and oil heaters are usually installed in duplicate and hence valves are provided at both inlet and discharge so that the idle unit may be shut off.

Flushing, N. Y. HARRY M. SPRING

THE ENGINEER'S BOOKSHELF

Power Handbook

MECHANICAL POWER TRANSMISSION HANDBOOK (1936)—*By William Staniar, Mechanical Power Engineer, E. I. duPont de Nemours & Co. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 488 pages 6x9 in., illustrated, tables. Fabrikoid covers. Price $5.*

Mechanical power-transmission equipment is being given more careful consideration now than ever before. New designs are being developed, old ones modified and new application methods and systems worked out. Power applications are being analyzed to obtain the most economical combination of electrical and mechanical equipment. All of this requires complete engineering information, a purpose for which this handbook has been prepared.

The book is divided into 15 sections: power belting, fastenings of power belting, power transmission by belting, flat-belt pulleys, steel shaftings, bearings, clutches, couplings, collars, short-center drive methods, chain drives, mechanical-transmission systems, high-starting-torque devices, infinitely variable speed control, gear-reduction units, lubrication of mechanical-power equipment, motors and miscellaneous data. In addition to general discussions, a wealth of data is presented in many tables and illustrations.

H. S. Diesels

HIGH-SPEED DIESEL ENGINES (1936)—*By L. H. Morrison, consulting engineer and editor of "Diesel Power." Published by American Technical Society, Drexel Ave. at 58th St., Chicago, Ill. 243 pages, 5x8½ in. 132 line illustrations. Fourth of a series. Price $2.50.*

Last year, about 80% of diesel production was high-speed engines, running at 800 r.p.m. and higher. Some went into stationary plants as standbys, emergency units, portable or isolated units, which is of special interest to the power engineer. In addition to standard, more complete texts, such a book as this will be of help. It deals with latest developments in a field which is changing very rapidly, and includes data on fuel-injection and combustion systems, frames and cylinders, running gear, and construction details of various models. Writing is loose, somewhat verbose, and non-technical.

A.S.T.M. Standards

A.S.T.M. STANDARDS (1936)—*Published and compiled by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Triennual, 2 vols., 2400 pages, 6x9 in., illustrations and tables. Bound in blue cloth or half leather. Price for former is $7.50 per volume, $14.00 for both; for latter $8.50 per volume, $16.00 for both.*

Completeness is one feature of the 1936 edition of A.S.T.M. Standards, as it contains all standard specifications, methods of testing, definitions and recommended practices adopted by the Society. Vol. 1 (910 pages) includes metallic substances only; of the 181 standards listed, 109 cover ferrous metals, wrought and pig iron and ferrous alloys. 60 relate to non-ferrous metals such as lead, zinc, copper, nickel, aluminum and their various alloys. The remaining standards involve metallography and general testing methods.

Vol. 2 (1480 pages) lists specifications and test methods for non-metallic materials such as cement, lime, gypsum, refractories, coal, timber, paints, rubber, insulators, oils and thermometers.

In the field of metallic substances, about 25 new and revised standards were adopted by the A.S.T.M. during 1936 and approximately an equal number of non-metallic standards. Both are included.

Diesel Plans

DIESEL APPLICATION PLAN BOOK (1936)—*Edited by John W. Anderson. Published by Rex W. Wadman, Diesel Engines Inc., 2 West 45th St., New York, N. Y. 296 pages (241 editorial), 9x12 in. Spiral-ring binding. Fabrikoid covers. Price $5.*

Says R. H. McDonnell of Burns & McDonnell Engrg. Co. in the Preface, "The following pages of this Plan Book are entirely devoted to various diesel layouts for utility, industry, marine, and transportation requirements. It is certain that these suggested typical installations will be of material assistance to those seeking further knowledge of the utilization of the diesel engine in the various fields. This book further reflects the active and intelligent efforts of the diesel-engine industry and its affiliations to acquaint the potential users of diesel power with the admirable and valuable qualities of this type of prime mover."

The book is divided broadly into three parts, specific diesel applications; general topics such as buildings, foundations and piping systems; and check lists. In each case there is a general discussion of the installation and a diagram. The whole book is printed in blue, and the drawings are clear and large. This reviewer's only suggestion is that later editions show actual dimensions of the space into which the plant is put.

Brief Reviews

INDUSTRIAL WIRING SURVEY. *Prepared by the engineering staff of the Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y., 18 pages, paper covers. Copies on request*—Designed to aid the plant engineer in detecting hazardous conditions, obsolescence and functional inefficiency by analyzing feeders and circuits. Charts and forms attached for listing all results of inspection.

COMBUSTION OF COAL ON THE SMALL UNDERFEED STOKER. *By Ralph A. Sherman and E. R. Kaiser. An abstract from Mining and Metallurgy (Sept. 1936). Published by the American Institute of Mining and Mechanical Engineers, 29 W. 39th St., New York, N. Y. Technical publication No. 750, nominal cost to non-members.*—An analysis of bituminous-coal reactions in underfeed stokers, and mechanical problems.

SMOKE & SOOT POLLUTION ANALYSIS. *By Frank H. Lamping, supervisor of the Smoke Abatement League, Cincinnati, Ohio. 22 pages, paper covers, mimeograph.*—An analysis of 212 soot-collection jars in Cincinnati. Copies available on request.

THE DEVELOPMENT OF DIESEL FUEL TESTING (1936). *By Dr. T. B. Hetzel, Research Assistant, Engineering Experiment Station, Pennsylvania State College. Published by the Station, State College, Pa., as Bulletin No. 45. 61 pages, 6x9 in. Paper covers. Price* $0.50—Pertinent data on a subject now very much in the diesel foreground. It describes and discusses bomb tests, chemical and physical chemical tests and engine tests for fuel, as well as the new Penn State apparatus and technique for testing. This new equipment is a modified C FR unit which operates as a diesel with electrical apparatus measuring times of injection and ignition. The test is based on measuring ignition lag. All fuels are injected at the same advance angle and the compression ratio adjusted so that the ignition point is at top center. The compression ratio so determined is used to compare the ignition quality of fuel samples with that of reference-fuel blends.

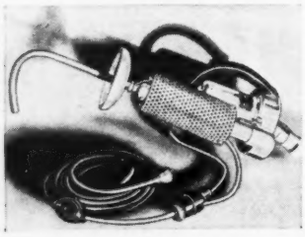
LORD KELVIN, MASTER OF HEAT AND COLD (1936). *By the Temperature Research Foundation, Kelvinator Corp, 420 Lexington Ave., New York, N. Y. 7 pages, 6x9 in. Paper covers. Free*—A brief biography of the "founder of the science of thermodynamics and father of electric refrigeration."

NATIONAL POWER & RESOURCES POLICIES (1936). *By Floyd A. Carlisle, chairman of the boards of Consolidated Edison Company of New York, Inc., and Niagara Hudson Power Corp. Available from those companies, free, 53 pages, 6 x 9 in. Paper covers*—Reprint of a Third World Power Conference paper.

ENGINEERING FEATURES OF SHAWINIGAN (1936). *60-page, beautifully illustrated, 9¼x11 in., booklet on Shawinigan Water & Power Co. developments. Copies available from the company at Montreal, Ont.*—Much technical information on hydro-electric power, electric boilers, experimenting, etc. Produced originally for Third World Power Conference.

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION (1935). *Published by U. S. Government Printing Office, as Publication 3348. 580 pages, 6x9 in. Paper covers. For sale by Superintendent of Documents, Washington, D. C., for $1.*—Includes 20-page "What Is Electricity?", by Paul R. Heyl, 16-page "The Approach to the Absolute Zero of Temperature" by F. Simon and D. Phil; 34-page "The Boulder Canyon Project," by Wesley R. Nelson.

WHAT'S NEW IN PLANT EQUIPMENT



ELECTRIC HEAT GUN

COMBINES 1000-watt electric heating unit and a hand vacuum cleaner, which provides large volume of warm air. Bell-shaped shield prevents grease from dripping on heater, further protected by heavy screen guard. Aluminum suction guard fits into cleaner nozzle, prevents dust and dirt from being drawn into gun. Air circulation provided by air-cooled, ball-bearing, 110-volt, a.c.-d.c. motor.

General Electric Co., Schenectady, N. Y.

BELTING

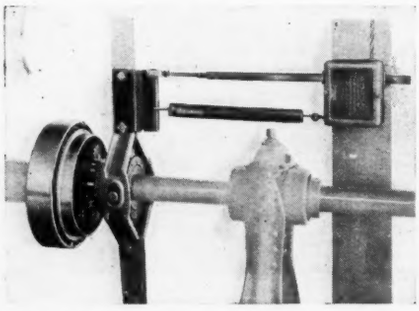
WIDE woven belting (up to and including 84 in.) to supplement "Balata" belts.

Victor Balata & Textile Belting Co., 53 Park Place, New York, N. Y.

AUTOMATIC DIESEL CONTROL

THREE standardized units have been developed in sizes 45, 90 and 140 kw., each consisting of one double-ended, 1,200-r.p.m., generator driven by two diesels through automatic over-running clutch couplings. A dual, air-operated "Tecomatic" exhaust temperature-recorder controller is furnished for each double-ended unit, providing automatic control and a daily recorded log of each engine operation. Control starts and stops an adjacent engine on an increase or decrease in load above or below capacity of its respective engine. Any number of units can be operated in parallel to govern a multiple-unit plant of any capacity. In multiple-unit a.c. application, generators float on line as synchronous condensers when not operating as generators.

Thermal Engineering Co., 716 Columbus Ave., Boston, Mass.



REMOTE-CONTROL CLUTCH RELEASE

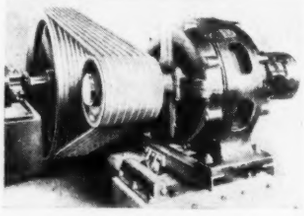
ILLUSTRATED is electro-mechanical latch mechanism connected to yoke of standard "Hilliard" friction clutch. Release box mounted at position shown or at some other location, providing that lever is three times as long as distance from fulcrum to shaft. May be operated with or without pushbuttons. Small current required as release opens its own circuit as soon as it operates, giving protection against arcing. Bulletin No. 127.

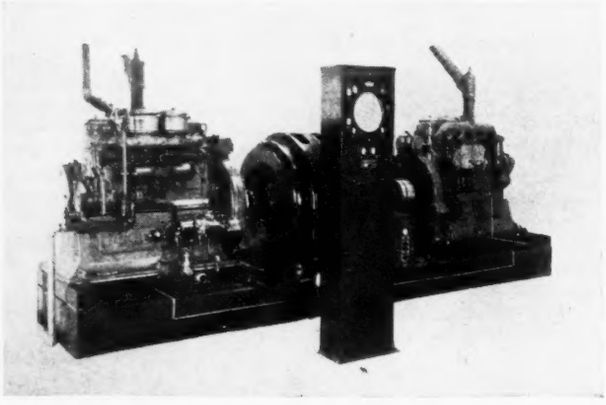
Hilliard Corp., Elmira, N. Y.

V-BELT DRIVES

PIVOTED motor base said to improve V-belt performance by maintaining constant tension in belts. Tension removed from belts when motor is not running, permitting belts to "rest," giving longer life. Vertical, ceiling, and floor-mounting (shown) types.

Rockwood Mfg. Co., 1801-2001 English Ave., Indianapolis.





FLEXIBLE COUPLING

THIS compact unit made with one body in form of a flange which bolts to clutch, flywheel or brakedrum. Flange-body design reduces over-all length of standard L-R coupling by one-third. Sizes 3 to 14 in. bores for 2,500 hp. at 100 r.p.m.

Lovejoy Tool Works, 4976 W. Lake St., Chicago, Ill.

SCALE REMOVER FOR DIESEL JACKETS

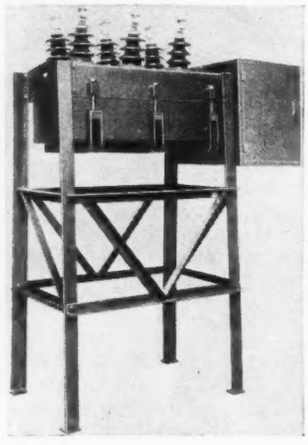
"H-O-H Special Cleaner," an acid compound, for rapid removal of scale where it is possible to circulate a solution. 100-, 300- and 500-lb. barrels. Bulletin.

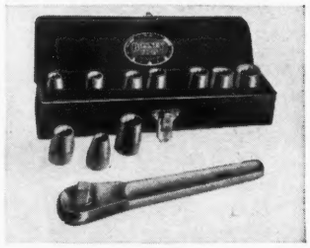
D. W. Haering & Co., Chicago, Ill.

OIL CIRCUIT-BREAKERS

OPERATE on oil-blast principle and are identified as Types FLO-1A, -1B, and -1C for interrupting ratings of 50,000, 100,000 and 175,000 kva. respectively at 15,000 volts. Horizontal break with three poles in single rectangular steel tank. Oil-blast ports provide rapid arc extinction with little burning of contacts. Main contacts wedge-and-finger type, with silver-to-silver contacts. Operating mechanism integral. Manually or solenoid operated.

General Electric Co., Schenectady, N. Y.





SOCKET SETS

CHROME - VANADIUM steel, chromium-plated, with heads buffed. Two sets: No. D with 10 sockets for ½-in. square drive and ratchet-handle with lug, and No. D-1, identical to No. D except for 15-in. hinge handle.

Bonney Forge & Tool Wks., Allentown, Pa.

WELDING ELECTRODES

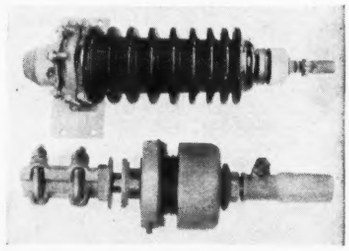
"MUREX" Type N electrodes designed for bridging gaps where fit-up between plates is small and on vertical or overhead work. Tensile strength ranges from 74,000 to 84,000 lb. per sq.in. with 26 to 24% ductility. Said to work equally well with either a.c. or d.c. and either straight or reversed polarity.

Metal & Thermit Corp., 120 Broadway, New York, N. Y.

REFRACTORY INSULATION

FOR backing up firebrick and waterwalls, "Insulblox," a block, and "Insulag," a plastic, have an approximate heat-storage capacity of 1/40th. Temperatures to 2,200 deg. F. Water added to "Insulag" makes it applicable plastic, said not to shrink on drying. Manufacturer claims that 1 in. of "Insulblox" is equal to 9 in. of firebrick.

Quigley Co., 56 W. 45th St., New York, N. Y.



CABLE TERMINATOR

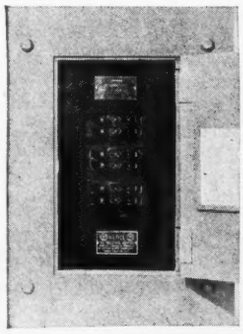
FOR use on oil-pressure cable. Lower end has standard wiping sleeve, top an expansion stud. Expansion member is oil-tight bronze bellows gasketed to external parts, and permits free expansion and contraction. Internal connector clamp is double-U-bolt. 46 kv., 750 amp.

Delta-Star Electric Co., 2400 Block, Fulton St., Chicago, Ill.

CIRCUIT-BREAKER PANELBOARD

"NOFUZE" panelboard designed for 115-, 115/230-volt a.c. service in a range of 4 to 40 circuits in two circuit steps. Bus arrangements are provided for single phase, 3-phase, 2-wire, and 3-phase, 4-wire services, with branch circuit ratings of 15 to 50 amp. Box dimensions 15x4 in.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



ELEVATOR ROLLER-GUIDE SHOES

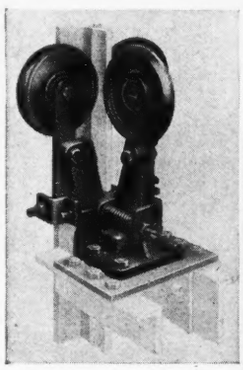
CONSISTS of rubber-tired wheels, supported by a spring action similar to "knee-action" of automobile, which roll silently on elevator guides. Manufacturer claims quietness and smoothness of operation and greater economy, as no lubrication is necessary.

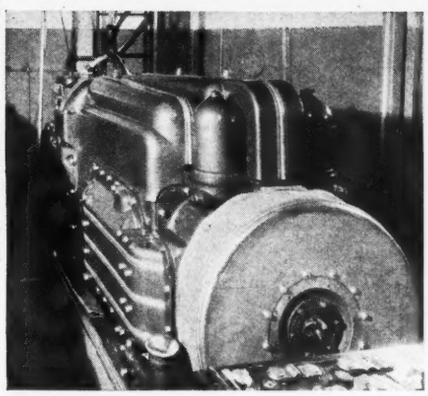
Otis Elevator Co., 11th Ave. & 26th St., New York, N. Y.

THERMOMETER-THERMOSTAT CONTROL

COMBINES dial thermometer with automatic thermostatic control. Line voltage micro-snap switches are used in thermostats and as limit switches in valves, making relays unnecessary on a.c. for all loads up to 1100 watts or ½-hp. motor. Operates on a temperature range of —40 to 650 deg. F. Two types: LS1, with single-pole switch and plain bulb of bronze or steel; and L2S1, with two independent single-pole switches with adjustable differential between "high" and "low" switch.

Sarco Co., Inc., 183 Madison Ave., New York, N. Y.





INCLINED-DISK DIESEL

MODEL CD-425, crankless, opposed-piston, 2-cycle, solid-injection diesel. Develops 150 hp. at 1,200 r.p.m. A compressor introduces into cylinders a flow of air under a pressure of 3 to 4 lb. per sq.in. to blow out all burned gases and provide air for compression and combustion. Bendix electric starter, force-feed lubrication, 4¼-in. bore, 5⅞ in. stroke, 4 cyl. Cover design by Count Alexis de Sakhnofsky.

Sterling Engine Co., Buffalo, N. Y.

HYDRAULIC MOTOR VALVES *(Left)*

FOR use with "Sarco" LS and L2S thermostats. A motor-driven vane pump builds up oil pressure in bellows chamber, compressing bellows, which operate valve pushrod. When thermostat opens electric circuit, valve returns automatically to closed position by spring pressure. Limit switches for both full and partial valve stroke. Throttling or open-and-shut valve. Bulletin No. 151.

Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

GAGE VALVES *(Photo left)*

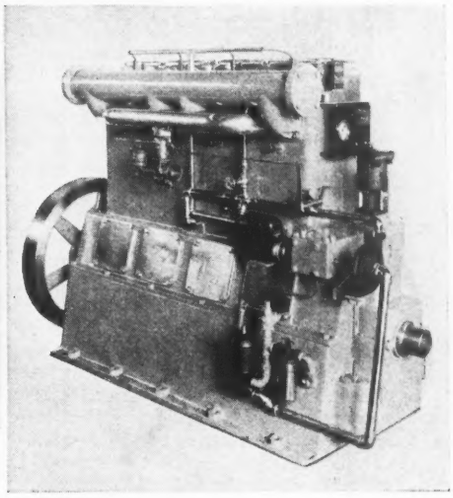
NEW line of forged-body valves with oversize handwheels and long taper-threaded bonnet joints. Working pressure ratings are from 4,000 lb. at 150 deg. F. to 475 lb. at 1,000 deg. F. Available in sizes from ⅛ in. to 1 in. in carbon and alloy steels.

The Edward Valve & Mfg. Co., Inc., East Chicago, Ind.

CONVERTIBLE DIESEL ENGINE

TYPE D, vertical, 4-cycle, solid-injection diesel engine, convertible to natural gas. 2, 4 or 6 cyl. for ratings of 50, 100 or 150 hp. respectively. Bosch unit fuel pumps, one per cyl., and injection nozzles. To convert to gas, spark plugs are inserted in place of fuel injectors, a magneto installed which drives off same shaft as fuel pump, and air-intake manifold added equipped with a natural-gas mixing valve. Manufacturer claims that two men can make conversion in one day.

Western Engine Corp., Los Angeles, Calif.



SWITCHGEAR

USED for across-the-line control of a 400-hp., 2200-volt, 3-phase squirrel-cage induction motor driving a 250-kw. d.c. generator and 20-kw. exciter. Front hinged door carries overload, under-voltage, temperature relays, control-switch and polyphase watthour-meter. Hinged side door gives access to the oil-blast circuit breaker and metering transformers.

Delta-Star Electric Co., 2400 Block, Fulton St., Chicago, Ill.

CO_2 NEUTRALIZER

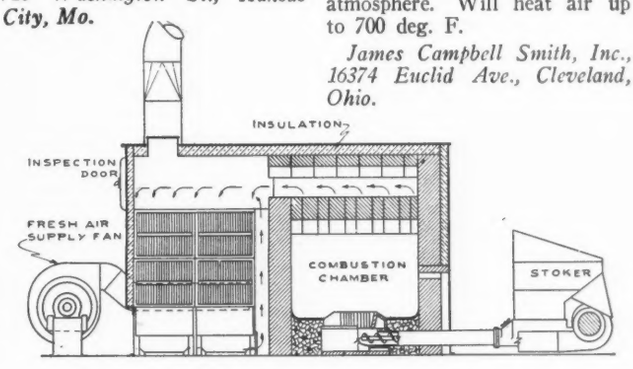
CORRECTS corrosive action in steam and condensate return line by absorbing CO_2. "CORAVOL" is a volatile. Continuous regeneration. Bulletin.

Western Chemical Co., 713-715 Washington St., Kansas City, Mo.

AUTOMATIC AIR HEATER

FOR industrial use, Smith automatic coal-fired air heater is essentially a combustion chamber to which coal is fed automatically by stoker under automatic control. One motor, thermostatically controlled, drives both fan and underfeed worm stoker. Combustion chamber encased in heavy steel plate, with upper part of walls and top arch heavily insulated. Air passes into combustion chamber and mixes with any unconsumed gases, which are burned before passing through heavy perforated arch, then travel to interchanger, where they are mixed with tempering air, drawn down between interchanger tubes and discharged to atmosphere. Will heat air up to 700 deg. F.

James Campbell Smith, Inc., 16374 Euclid Ave., Cleveland, Ohio.



POWER STAFF BUILDS FOR 1937

Tangerman Becomes Managing Editor

E. J. Tangerman, associate editor of *Power*, has been appointed managing editor effective Jan. 1. Under general supervision of Philip W. Swain, editor, he assumes responsibility for editorial operation of the publication.

"The appointment of Mr. Tangerman as managing editor," said Mr. Swain, announcing the promotion, "is recognition of exceptional journalistic and managerial ability, repeatedly demonstrated. It also marks, in my opinion, a major step in organization of the editorial staff for greater practical service to readers. During the past four and a half years, Mr. Tangerman has planned and executed a number of outstanding editorial projects, notably *Power's* annual tables of diesel and gas-engine installations, the history of the power field (June, 1934), the basic plan for our present very popular special sections and our unique index-type contents page. During my absence in Europe in the spring of 1936, he was in active editorial charge. His versatility, his ability to decide and act quickly, and his intensely practical outlook will be reflected, more than ever, in the pages of *Power*."

A native of Indiana, and son of a railway-shop general superintendent, Mr. Tangerman early worked as a newsboy and printer's "devil," completed a machinist apprenticeship, and also served as boiler-maker, crane operator, rigger, electrician, pipefitter, and finally as assistant machine-shop foreman. With money thus earned he entered the mechanical-engineering course at Purdue University, from which he was graduated with distinction in 1929. There he was active in all lines of journalistic endeavor, acting during his senior year as editor-in-chief of the daily *Purdue Exponent*, colonel of the R.O.T.C. and president of several honorary societies.

Since that time, he has served continuously with McGraw-Hill publications, first on *American Machinist* and *Product Engineering*, and since June of 1932 as assistant editor and then associate editor of *Power*. He is also technical editor of *Mill Supplies*. His duties on *Power* have included every journalistic phase of editorial work, and in addition such technical specialties as diesel and gas engines, engineering materials, welding, painting, metal spray, and smoke and flue-dust elimination. He is the author of many technical and non-technical articles and editor of "The Power Operator's Guide," a compilation of 1001 practical aids published last year.

While carrying a heavy schedule on *Power*, Mr. Tangerman has found time for such avocations as whittling, wood carving and work in the U. S. Army Reserve. His whittling has revealed itself in several *Power* covers incorporating models, in a number of articles in popular magazines, in Boy Scout pamphlets, and in the just-published book "Whittling and Woodcarving." As a captain, Field Artillery Reserve, U. S. Army, he commands a battalion. He is a member of the A.S.M.E. and the A.W.S., in the latter a member of the New York Section executive committee and the national publicity committee.

Coleman Joins Staff

S. H. Coleman, Jr., recently results engineer with Dupont Rayon Co., has been appointed assistant editor of *Power*. Well known to *Power* readers as a contributor of practical articles on plant operation, Mr. Coleman has had fourteen years of well-rounded operating experience.

After several years of college study of engineering, he was employed by the Norfolk & Western Railroad, during 1923 and 1924, as signal electrician. This was followed by four years of power operation with the Viscose Corp., Roanoke, Va., where he advanced through the grades of power-house clerk and utility man to the position of assistant chief engineer in charge of all operation, maintenance and testing in one of the two power houses—a 16,500-kw. stoker-fired plant.

In 1929 Mr. Coleman became plant power engineer for the Dupont Rayon Co. in Waynesboro, Va., in responsible charge of its 450-lb.-pressure, pulverized-fuel-fired plant of 300,000-lb.-per-hr. steam capacity, as well as the generation and distribution of all the power services.

After two years with Dupont Rayon, he was made chief engineer of Reid Murdoch & Co., food manufacturers, Rochester, Minn. While there he modernized the steam-generating equipment and did extensive work in the elimination of boiler-water carryover troubles. Returning to Dupont in 1933 as shift engineer, he was promoted later to results engineer, in charge of power-service conservation throughout the manufacturing plant. Mr. Coleman holds a Minnesota chief engineer's license, and is a member of the N.A.P.E., serving as deputy president for Virginia during 1936.

As a member of *Power's* editorial staff he will keep in touch with power-service generation and distribution in industrial plants, buildings and institutions, with particular reference to the practical problems of every-day operation.

New Staff Assistant

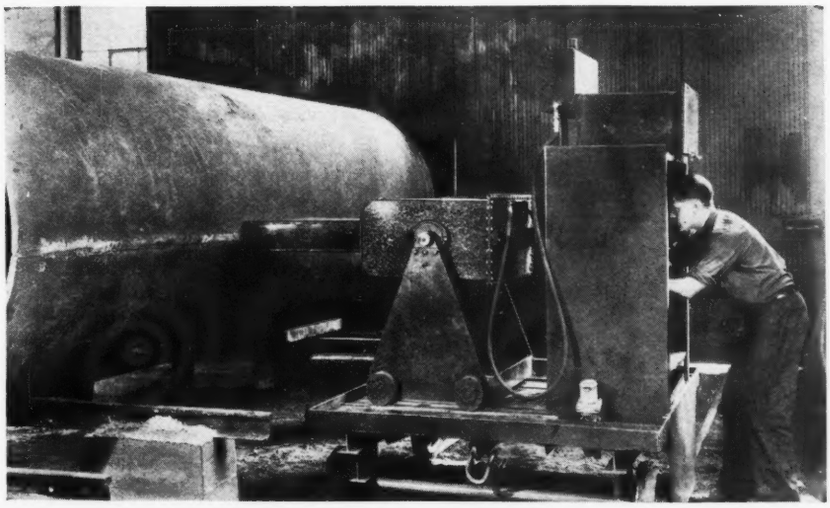
Bayard E. Sawyer has joined the staff of *Power* as editorial assistant, with duties concerned principally with news and mechanical production of the magazine. Graduated from Purdue University in 1935 with the degree of Bachelor of Science, he spent the following year in Panama working for Chiriqui Land Co., a division of United Fruit Co. While at Purdue, Mr. Sawyer was intensely interested in journalistic work, being on the staff of the University daily paper during his entire college career and acting as editor-in-chief his senior year. He has a good working knowledge of Spanish, and his early life was spent in a number of foreign countries. Born in the Philippines, he was educated in Guatemala and Colombia as well as in Connecticut, Illinois and Indiana.

POWER'S History

POWER was founded in 1884 by E. P. Harris and H. M. Swetland. With it was incorporated *Steam*, which had been started by N. Hawkins in Chicago two years earlier.

In 1903 *Power* purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely, *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trades Magazine, Home Study for Electrical Workers* and *Steam Electric Magazine*.

In 1908 it absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power and Machinery Magazine, The Stationary Engineer, Engineers and Power Users Magazine, Steam Engineering* and *The Mechanical Engineer*. When *The Engineer* was purchased, the name of the combined paper was *Power and The Engineer*. The title was condensed to *Power* in 1911. All rights to the above titles reserved.



FIRST BARREL AND DOME ARC-WELDED IN BOILER

Barrel for high pressure boiler, said to be first of its type ever built with barrel and dome arc-welded to U-68 (Class I) A.S.M.E. rules. Is 16½ ft. long, 62½ in. outside diameter, made of steel plate 1.15 in. thick, and will soon be on its way to the oil fields. Fabricated by Farrar & Trefts, Inc., Buffalo, N. Y., by shielded arc process.

POWER LINES

4 Utilities Spend $14,150,000 in New Developments

With the close of 1936, four large utility corporations announced expansion programs that will cost approximately $14,150,000. These developments are scattered in Kentucky, New York, Arkansas, and Connecticut, indicating that increased electrical power consumption is expected throughout the country.

Stone & Webster Engrg. Corp., Boston, Mass., will build two of the new developments—Hartford Electric Light Co.'s $3,500,000 steam turbo-generating unit for the South Meadow station, and Williamsburgh Power Plant Corp.'s $4,350,000 addition.

The Williamsburgh Power Plant Corp., principal source of electric supply of the Brooklyn Manhattan Transit System, will install two 25,000-hp. turbine-generators, two coal-fired boilers, each to produce 575,000 lb. of steam per hr., and auxiliary equipment. The new equipment will superimpose on existing turbines.

The new unit for Hartford Electric Light Co., Hartford, Conn., includes a 40,000-kw., 11-kv. steam turbine, a 400,000-lb.-per-hr., 850-lb. pressure, 900-deg. F. boiler to be placed in service in the spring of 1938. At present the plant contains one 40,000-kw. steam unit, two 20,000-kw. steam units, and one 10,000-kw. mercury unit.

In Arkansas, a third large hydro-electric project will be constructed by the Arkansas Power & Light Corp. on the Ouachita River at Blakeley, 15 miles northwest of Hot Springs, and 25 miles above Carpenter dam. This plant is expected to develop 31,700 hp. and will tie in with the Carpenter and Remmel hydro-electric plants on the Ouachita. C. S. Lynch, chief engineer of Arkansas Power & Light Corp., will be in charge of construction work, which will cost approximately $4,000,000. This company is also adding a $500,000, 10,000-kw. generator to the Little Rock power plant, with turbine, boilers and auxiliary equipment.

Louisville Gas & Electric Co., Louisville, Ky., has already begun construction of a $60,000, 28x77-ft., 4-story, steel-and-concrete building to house an additional 25,000-kw. generating unit for its Canal St. station. This unit includes a boiler supplying steam at 450 lb. and 750 deg. F., and will cost approximately $1,800,000.

Acetylene Association Reveals Welding and Cutting Progress

Meeting in St. Louis, Nov. 18, 19 and 20, for its 37th annual convention, the International Acetylene Association presented a well-rounded program of practical papers on welding and cutting with the oxy-acetylene torch. The industry, it was shown, has moved a long way since its birth in 1892. Discussing this history, retiring President Epperson stressed present very-high safety standards in the production, packaging, shipping and use of compressed gases—largely the work of the Association.

Erik Oberg, editor of *Machinery*, showed how welding and gas cutting have revolutionized machine design and construction. The extreme flexibility of the process and the elimination of most patterns and castings cleared the road for rapid improvements in design without costly changes in manufacturing equipment and patterns. Fear of increased cost greatly retarded progress in the past.

Outstanding savings have resulted in the case of heavy machine frames for electric generators and hydraulic turbines. Two or three of a kind are now cut and welded in less time than it formerly took to make a pattern. Welding and gas cutting free the designer from many artificial limitations. But welded construction calls for designs fitted to the welding process, not copies of the old cast designs.

Nearly 300 members and guests attended the opening luncheon at which P. W. Swain, Editor of *Power*, delivered the keynote address. After outlining his observations of engineering developments in Europe, he concluded that America is today the world's leading engineering nation and offers possibilities for further developments that stagger the imagination.

But how, Mr. Swain asked, can all this tremendous mass of technical knowledge be made available to each new generation? He urged that each field of practical knowledge have its primer—an A.B.C. summary for the man in the street and for the man busy with other specialties.

Outstanding special features of the convention were a demonstration of welding and cutting before a general audience of 1500 and a welding and cutting round-table session. In the latter, groups of experts in various phases of welding held "clinics," open to anybody with a question.

Power Transmission Manufacturers Reorganize

Power Transmission Council and Mechanical Power Engineering Associates merged into one body, Power Transmission Council, Inc., effective Dec. 3. The change was made "to set up a more businesslike structure and to enable the association to go forward . . . and enlarge as well as improve its effort on behalf of the entire industry."

Officers of the new organization are: president, A. P. Homer; vice-president and chief engineer, V. A. Hanson; treasurer, D. W. McAllen; and secretary and assistant treasurer, Miss D. M. Rae.

The board of directors includes: C. E. Brinley, American Pulley Co.; M. M. Jones, Akron Belting Co.; P. C. Brown, I. B. Williams & Sons; W. H. Fisher, T. B. Wood's Sons Co.; A. P. Homer; B. A. Keiley, R. & J. Dick Co, Inc.; R. M. Pindell, Jr., Alexander Bros., Inc.; J. E. Rhoads, J. E. Rhoads & Sons; Col. A. F. Townsend, Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc.; F. H. Willard, Graton & Knight Co.; and W. W. French, Dodge Mfg. Corp. Secretary's office is 75 State St., Boston, Mass.

MEETINGS

National Marine Engineers' Beneficial Assn.—*61st Convention, Jan. 25–30, Lee House Hotel, 15th and L Sts., Washington, D. C. A. L. Jones, secretary-treasurer, 313–316 Machinists Bldg., Washington, D. C.*

National Oil Burner & Air Conditioning Exposition & Convention—*March 15–19, Convention Hall of Commercial Museum, Philadelphia, Pa. Oil Burner Institute, New York, in charge. C. F. Curtin, secretary.*

Leipzig Fair—*Feb. 28 to March 8. Leipzig, Germany. Spring Fair will be 1977th in 700 years.* 8,000 exhibits.

Louisiana Engineering Society—*Jan. 22–23, annual meeting, St. Charles Hotel, New Orleans, La.*

Smoke Prevention Assn. and Fuel Burning & Air Pollution Exhibition—*31st Annual Convention, May 31–June 5, Hotel Pennsylvania, New York, N. Y. Frank A. Chambers, secretary-treasurer of S.P.A. and smoke inspector of Chicago, in charge.*

A College for Power-Plant Men

An interesting development in practical power-plant engineering is in progress at Cincinnati, Ohio, where Ohio Mechanics Institute is conducting a 4-year night-school course in power engineering, presented from the operator's point of view. Several years ago, a simple course in stationary engineering was started, followed by other courses as engineers, oilers and firemen demanded more knowledge.

The standard 4-year course, conducted three evenings a week, consists of Physics, Algebra or Practical Arithmetic, Stationary Engineering, Chemistry, Practical Electricity, Heating & Air Conditioning, Mechanical Drawing, Refrigeration, Feed Water Conditioning, and Combustion, and it is possible to register for any individual course or combination of courses.

Interest and attendance have increased each year since the course was started, the Institute reports, indicating an effective method for operators and men in the average plant to follow new developments and advance their general knowledge.

102,000-Hp. Hydro Plant To Be Built in Arkansas

White River Power Co., a subsidiary of Arkansas Power & Light Co., was granted license authorization Dec. 16 by the Federal Power Commission to build a hydroelectric plant at Wild Cat Bend on the White river, Baxton and Marion counties, Ark. The company's application included two other developments on the White River, at Bull Shoals and Hog Thief Bend, which were denied on the grounds that no evidences of engineering or economic feasibility were presented.

The Commission authorized the construction of a dam, reservoir, power plant and auxiliaries in two steps. The first, to be completed within 4½ years, consists of a dam with its spillway crest 484 ft. above sea level and two generating units having a capacity of 38,000 hp. The second will be the addition of piers and gates to the spillway and a third generating unit, making a total capacity of 102,000 hp.

Plans for the project must be redesigned in accordance with a report of the Chief of Engineers, U. S. War Department, however, before an actual license will be issued. These plans must be submitted to the Commission on or before June 1 for the license authorization to hold.

Manufacturers Extend Olive Branch

Extending the olive branch to government and labor, the National Association of Manufacturers adopted a new declaration of principles at its meeting in New York, Dec. 9-10. Highly cooperative in tone, and burying the axe of previous struggles, this code for industry linked the basic principles of private initiative with the desires of the American people for greater security and a broader and sounder prosperity.

Excerpts from the resolution follow:

"Better living, better housing, more necessities, comforts and luxuries, steadier work, more certainty of a job, more security for old age—these . . . are the progressive objects of American industry.

"The American business system has made possible the striking continuity in the rise of our standard of living . . . But . . . new opportunities and responsibilities challenge industry to even greater accomplishments . . . We believe that the greatest future progress is possible under a competitive private enterprise, profit and loss system . . .

"Manufacturing industries exist to produce and distribute goods and services so that the entire people have a living and so the standard of that living may constantly be raised . . . Industry must continue to improve its employment relations, machines, production methods and distribution so that all of the people may get more of the things they want at relatively low prices . . . There should be no artificial barriers to the equality of opportunity for the individual to progress from one economic level to another . . .

"We oppose any monopoly in production, distribution or labor which restricts or stifles competition and which imposes a burden of unfair high prices on the consumer . . . We condemn any undesirable practices and abuses in industry and pledge vigilance . . . to bring about their correction.

"The true function of proper government . . . is to protect the individual in the exercise of his rights . . . Industry pledges its cooperation with government in the promotion of economic and social progress . . .

"Government competition with private industry is injurious and unsound . . . We favor creating economic security for each citizen without limitation of his individual opportunities and responsibilities for creating such security for himself.

"We believe in and support the right of labor to seek, secure and retain employment without regard to membership or non-membership in any organization, and to bargain without interference or coercion by any one, either collectively or individually. We believe in the correlative right of the employer to be free from coercion by any one . . . We . . . are unequivocally opposed to child labor as well as to sweatshops in manufacturing . . .

"Under our industrial system wages have been raised, working hours lowered, and living standards at the same time have greatly advanced . . . We believe this improvement will continue under the American system of free enterprise and that wage and hour changes will be made as the improved production methods make them possible.

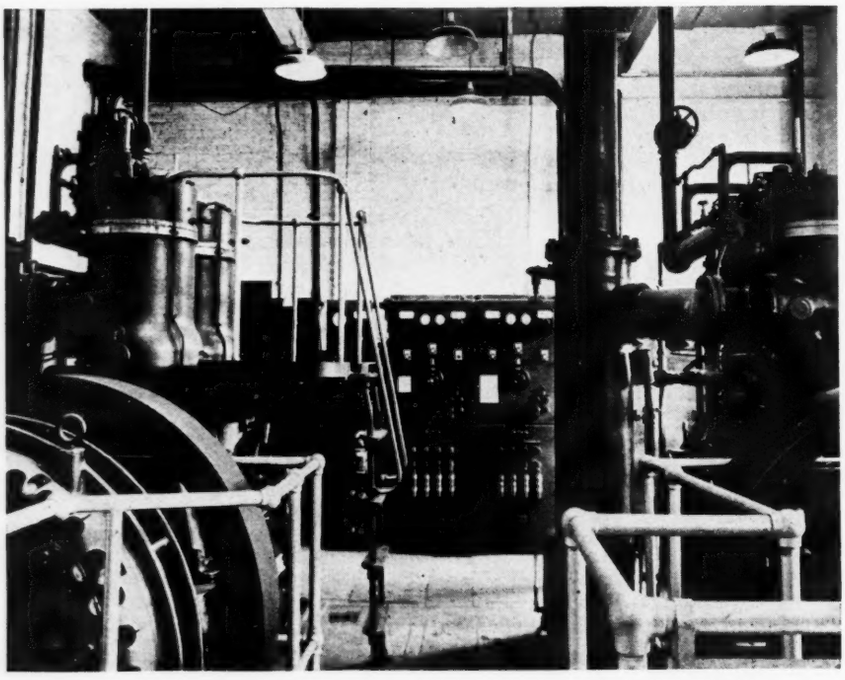
"We desire to advance our trade with foreign nations . . .

"The progress of American industry is an evidence of the fruitfulness of peace—peace at home—peace with all nations.

"We pledge our cooperation to government—local, state and national—in the furtherance of those measures which will promote the best interests of the American people . . ."

SILENT DIESELS

Two Fairbanks-Morse, Maxim-silenced 120-hp. diesel engines direct-connected to two 2-phase generators at the plant of the United States Cabinet Bed Co., in the residential district of Brooklyn, N. Y., operate without trouble from exhaust noise



OBITUARIES

LEON CAMMEN, 61 inventor, and for the last 25 years a consultant for the A.S.M.E., died Dec. 4. Mr. Cammen, born in Russia, came to America in 1907, and during the war was a technical consultant to the U. S. government.

COL. WILLIAM D. SWART, 80, president and director for the past 20 years of the Nashua Machine Co., maker of the Bundy steam trap, died Nov. 28 in Nashua, N. H., following a long illness.

PROF. FRANK A. LAWS, a member of the M.I.T. teaching staff for the past 43 years, and a specialist in the field of electrical measurements, died at his home in Brookline, Mass., Nov. 12.

WEAVER MARSTON, 39, sales manager of the Sharples Specialty Co., Philadelphia, Pa., died Nov. 26 as the result of an automobile accident at West Chester, Pa. He had been with the company since 1926, first

as assistant sales manager, then as manager of the California company, and since 1931 in his present position.

JOHN F. LYONS, 64, substation maintenance foreman for the Narragansett Electric Co., Providence, R. I., died suddenly at his home in that city Nov. 15.

DR. AUGUSTUS H. GILL, 72, professor of chemical engineering at M.I.T. for many years and a former member of the A.S.T.M., died at his home in Belmont, Mass., Nov. 11.

GEORGE H. BIRD, superintendent of maintenance and construction at Franklin Union, Boston, Mass., for the past 28 years, died Nov. 12 at his home in Dedham, Mass.

LOUIS P. TOWER, president of the James H. Tower Iron Works, Providence, R. I., died Nov. 15.

ALFRED CHARLES MORTIMER, for 17 years superintendent of the Mead Morrison Mfg. Co., East Boston, Mass., died recently.

LEE B. METTLER, 62, president and founder of the firm of the same name in Los Angeles, Calif., combustion engineer and maker of gas burners, died Nov. 13 from a heart attack.

I. EDWARD BRITT, 43, chief engineer for the Societé Anonyme des Foyers Automatiques and Raymond Brothers Co., Paris, France, died recently at his home in Paris. Mr. Britt was born in Virginia, and in 1920 went to Belgium to make a complete powdered coal installation at the largest steel plant in that country.

W. E. KIMBALL, plant engineer of the Boston refinery of American Refinery Co., died in New York Dec. 1, shortly after he became suddenly ill at the luncheon of the Sugar Section, A.S.M.E.

GEORGE GREGG WELCH, 77, for many years with the Twin State Gas & Electric Co., died in Dover, N. H., Oct. 20.

J. HOLLIS READ, assistant superintendent of the Manchester, N. H., water works, died in Manchester Nov. 17.

SCHOOLS and SOCIETIES

AMERICAN STANDARDS ASSOCIATION, at its annual dinner meeting held in New York, Dec. 7, re-elected as president Dana. B. Barnum, head of the Boston Consolidated Gas Co., and renamed as vice-president E. A. Prentis, of Spencer, White & Prentis, Inc., New York, N. Y. During the year, the Association approved 66 new and revised standards in various industrial and engineering fields.

OHIO STATE UNIVERSITY, Columbus, Ohio, will open a 3-week diesel school about Feb. 1 at the university. Ohio State is one of 8 land-grant colleges having simultaneous diesel-engine schools during February, others being Wisconsin, Minnesota, Michigan State, Purdue, Illinois, Iowa State, and Nebraska.

UNIVERSITY OF ILLINOIS will open a 3-day "short course" in coal utilization May 25. Detailed program will be available about April 1 from D. R. Mitchell, Mining & Metallurgical Engrg. department.

THE MASSACHUSETTS DIESEL INSTITUTE has established a new home at 88 St. Stephens St., Boston, Mass. A. H. Cagne is president and managing director.

L. H. HILL has been named engineer-in-charge of the Transformer Division of Allis-Chalmers Mfg. Co., Milwaukee, Wis., to succeed the late L. C. Nichols. Mr. Hill was manager of the Transformer Division of American Brown Boveri Co. at the time it was absorbed by Allis-Chalmers.

A. M. BYERS CO., Pittsburgh, Pa., has announced the following changes in personnel: George B. Cushing, formerly head of the Engineering Service Department, is now manager of sales promotion; B. D. Landes, who has been in the Engineering Service Department since its inception, is now its manager. R. H. Gardner, formerly of the Byers Washington office, has been appointed manager of pipe sales.

ARTHUR NEWELL TALBOT, 79, professor emeritus of engineering at the University of Illinois, has been awarded the 1937 John Fritz Gold Medal, one of the highest American engineering honors. Prof. Talbot was cited as "a moulder of men, eminent consultant on engineering problems, leader of research, and outstanding educator in civil engineering." The award is made annually for notable scientific or industrial achievement by a board composed of 16 past-presidents of the four national societies of civil, mining and metallurgical, mechanical, and electrical engineers.

NORDBERG MFG. CO., Milwaukee, Wis., has acquired the American license for building Burmeister & Wain 2-cycle diesels. For the past few months, Emil Grieshaber, chief engineer, and Rudolph Wintzer, consulting engineer, have been in Copenhagen becoming familiar with the design, construction and operation of these engines.

HARRY A. HAGEMAN, formerly chief hydraulic engineer of Stone & Webster Engineering Corp., Boston, Mass., has been appointed chief hydraulic engineer to TVA, with headquarters at Knoxville, Tenn. For the past 5 years, Mr. Hageman has been city building commissioner of Newton, Mass.

WILLIS H. CARRIER has been voted an honorary member of the Japanese Association of Refrigeration in recognition of the 25th anniversary of Mr. Carrier's presentation of psychometric formulas on which the art of air conditioning is generally considered to rest.

GENERAL REFRACTORIES CO., Philadelphia, Pa., recently named the following men to the board of directors: Lionel Y. Greene, vice-president in charge of operations; Russell P. Huer, vice-president in charge of research; and Drew M. Thorpe, vice-president in charge of sales.

STRAWS

Pointing the way business winds blow

BABCOCK & WILCOX CO. will re-open its Bayonne, N. J. plant, which has been shut down for several years. About 150 men will be employed at first.

BIGELOW-SANFORD CARPET CO., INC., Thompsonville, Conn., is changing all boiler equipment over to fuel oil with automatic combustion control, and will install an 1875-kw. non-condensing steam turbo-generator. This work will be completed in several months.

PULLMAN STANDARD CAR MFG. CO., Mountain St., Worcester, Mass., is considering rebuilding of power plant at local railroad-car manufacturing works, recently destroyed by fire. Loss close to $60,000.

BOSTON LAUNDRY & SUPPLY CO., Boston, Mass., has plans for new boiler plant. Cost about $25,000. D. D. Eames, 739 Boylston St., consulting engineer.

COLUMBIA GAS & ELECTRIC CORP., New York, N. Y., plans welded steel pipe line from terminus of present lines in Pennsylvania to Wilmington, Del., in cooperation with Delaware Power & Light Co. Booster stations along route. Delaware company will build a large control and distributing plant at Wilmington. Cost over $1,500,000.

CORNING GLASS WORKS, Fibre Products Division, Corning, N. Y., has begun foundations for three new buildings to have a total area of 46,000 sq. ft.

SOUTH

RESIN PRODUCTS CORP., Savannah, Ga., recently organized, care of Industrial Committee of Savannah, Inc., Savannah Bank & Trust Co. Bldg., Savannah, plans steam power house at new soap-manufacturing plant in Hermitage Plantation district. Entire project will cost close to $100,000.

WILBUR J. CARTER, Greensboro, N. C., plans power house for heating and operating service at local rayon weaving mill. Cost about $250,000. Contract for building let to Charles W. Angle, Inc., Greensboro.

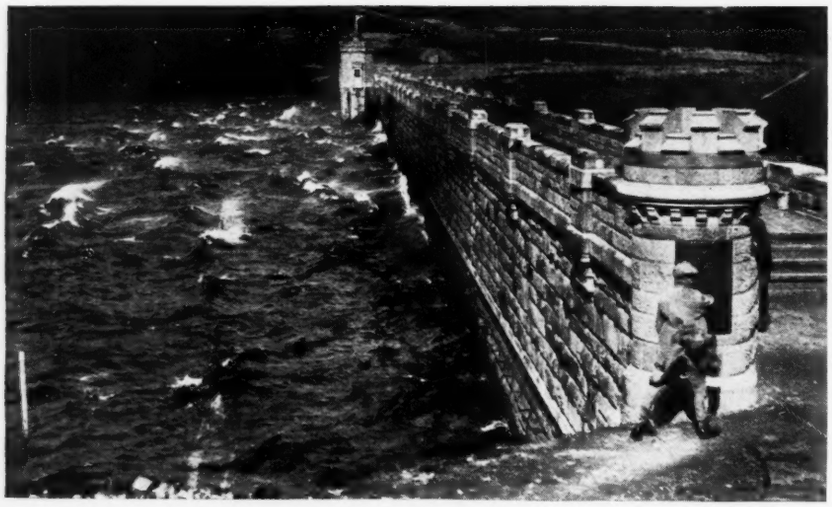
BOARD OF SEWAGE COMMISSIONERS, Louisville, Ky., contracted Charles E. Connell Co., 2138 South Floyd St., Louisville, for four electric-operated vertical pumping units and auxiliary equipment for Point sewage pumping station.

CLEVELAND, MISS., plans three large electric-operated pumping stations in municipal sewage disposal works. Fund of $227,000 for entire project.

PLANT CITY, FLA., contracted I. H. Smith Co., Barnett Bldg., Jacksonville, Fla., for municipal gas plant and distributing system, including control station. Cost about $155,000, of which $100,000 through Federal aid.

KINSTON, N. C., plans extensions in municipal plant and waterworks at West Kinston. Cost about $100,000.

PENNSYLVANIA WATER & POWER CO., Baltimore, Md., has awarded a contract for the supply of about 2000 tons of transmission towers for a 200,000 volt line to the Blaw-Knox Co., Pittsburgh, Pa.



Rough weather turns Bradford power plant's (near London) new $11,250,000 reservoir into a raging sea *Globe-Fox*

VIRGINIA STATE CORPORATION COMMISSION has granted Appalachian Electric Power Co. three years more to complete its New River dam project under license secured Oct. 25, 1932.

DANVILLE, VA., recently announced that it had received an additional PWA grant of $92,000 for its hydroelectric project, making a total allotment of $1,329,954. The $92,000 will be used to preserve the landscape so that the development will not destroy the beauty of the section in the event a park is desired later.

OXFORD, MISS., plans extensions and improvements in municipal power plant, including installation of new 750-hp. engine-generator unit and accessories. Special election called Jan. 12 to approve bond issue of $55,000.

NORTH BATON ROUGE WATER WORKS, Baton Rouge, La., plans construction of several pumping plants. Cost about $625,000. $281,320 through Federal grant. E. G. Blakewood, Baton Rouge, consulting engineer.

HIGH POINT, N. C., will begin construction on a municipal power project on the Yadkin river, 12 miles from Winston-Salem. The PWA has approved a grant of $2,595,000.

KAPLAN, LA., is considering a steel pipeline for municipal gas system. Bond issue of $25,000 will be arranged.

AMERICAN ENKA CO., Enka, N. C., has completed plans for addition to steam power house at rayon mill, and will begin construction at early date. Cost over $50,000, with equipment.

SOUTHWEST

MAGNOLIA PIPE LINE CO., Dallas, Tex., has surveys nearing completion for 85-mile 8-in. welded steel pipe line from Tilden to oil terminal at Corpus Christi. Booster pumping stations will be installed at points along route. Will also install two 80,000-bbl. steel tank units, pumping machinery and accessory equipment at Tilden. Cost close to $800,000. Company is a subsidiary of Magnolia Petroleum Co., Dallas.

HUMBLE OIL & REFINING CO., Houston, Tex., is surveying 125-mile route for 10-in. welded steel pipeline from gas field area at Tomball, to point near Houston, with 10-in. branch lines to Beaumont, Port Arthur, Baytown and Port Neches, Tex. Booster service to develop total capacity of about 60,000,000 cu. ft. per day. Control and distributing stations will be built in different municipalities. Line construction will be carried out by Humble Pipe Line Co., an associated interest. Cost close to $2,000,000.

DUKE POWER CO., Charlotte, N. C., contracted Westinghouse Electric & Mfg. Co., for 75,000-hp. turbo-generator unit and accessory equipment for River Bend plant on Catawba River. Cost approximately $3,000,000, including transmission line.

COSDEN PIPE LINE CO., Tulsa, Okla., has awarded a contract to the Sheehan Pipe Line Construction Co., Tulsa, for building a 22 mile, 4 in. line from Wewoka to Fittstown, Okla.

B & M CONSTRUCTION CO., Oklahoma City, Okla., will lay a 22 mile, 6⅝ in. natural gas pipe line for Vicksburg, Miss., to extend to Jackson, Miss.

BENNETT CRUDE OIL PURCHASING CO., Houston, Texas, is constructing a 10 mile, 6 in. oil line from Kent Field to Texas City, Texas.

OKLAHOMA PIPE LINE CO., Tulsa, Okla., has awarded contracts for 2 new loops which are part of a current-relooping program. White Deere Pipe Line Construction Co. will lay 15 miles of 8 in. line near Cromwell, Okla., and J. R. Stewart Construction Co. will construct another 15 mile, 8 in. line north of Hewitt Station, Okla.

PONCA CITY, OKLA., will soon receive bids for extensions and improvements in municipal electric plant, including 1,500-kw. diesel set and accessories. Cost about $175,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

WEST

SACRAMENTO VALLEY UTILITY CO., 943 Russ Bldg., San Francisco, Calif., plans hydro-electric plant on Upper Narrows Dam, Yuba River, Nevada County. Will utilize surplus water power created by dam and will be equipped for initial capacity of 12,000 kw. Includes transmission line to points in northern Calif. Cost over $650,000.

WRIGHT WINERY & DISTRIBUTING CO., 3319 Colby Ave., Everett, Wash., plans 1-story boiler house. Cost about $20,000.

BOARD OF TRUSTEES, State Hospital for Insane, Pueblo, Colo., plans extensions and improvements in power plant at institution. Cost about $65,000. A new cold storage and refrigerating plant is also proposed, to cost close to $100,000, and new pumping station for water supply, including pipe lines, to cost about $35,000. Appropriations will be arranged by State Legislature.

HOLLY SUGAR CORP., Colorado Springs, Colo., plans power house at new multi-unit beet-sugar mill at Hardin, Mont. Plant is scheduled for completion in summer of 1937, and will cost about $1,000,000.

NATIONAL ICE & COLD STORAGE CO., Riverside, Calif., has contracted Gay Engineering Co., Los Angeles, Calif., for new 2-story precooling plant, 72x95 ft., with capacity for 50 cars of fruit at one time. Cost close to $80,000, with equipment.

HAVRE, MONT., will ask bids soon for steel pipeline for municipal gas distribution, including control and distributing station. Fund of $165,000 has been secured through Federal grant and loan. Orvil Stromberg, mayor, in charge.

DENVER UNION STOCKYARDS CO., Union Stock Yards, Denver, Colo., has plans for new multi-story pumping station. Cost estimated over $45,000. Jay W. McCullough, Majestic Bldg., consulting engineer.

MIDWEST

UNION CITY, OHIO, is considering new municipal power plant and will apply for Federal financing in amount of $130,000 at early date. Bids will be asked after appropriation has been secured. Hoover & Montgomery, Atlas Bldg., Columbus, Ohio, consulting engineers.

REPUBLIC IRON CO., Ironwood, Mich., plans addition to power plant, including new engine house. Cost over $30,000.

COFFEYVILLE, KAN., contracted Westinghouse Electric & Mfg. Co., for 5,000-kw. steam turbo-generator unit and auxiliary equipment at $107,710; also for condenser unit at $37,303. Award for addition to station has been made to Universal Construction Co., Coffeyville, at $23,315. Total cost about $200,000. Black & Veatch, Kansas City, Mo., consulting engineers.

ATLAS WAREHOUSE & COLD STORAGE CO., Green Bay, Wis., has approved plans for addition to cold-storage and refrigerating plant. Cost close to $50,000. G. J. Feldhausen, City Center Bldg., architect.

STORM LAKE, IOWA, is considering a municipal power plant, and will have surveys and estimates made in near future.

BENTON HARBOR, MICH., plans installation of motor-driven pumping machinery and other power equipment. Fund of $170,000 through Federal aid. Ayres, Lewis, Norris & May, Ann Arbor, consulting engineers.

YUBA, WIS., plans rebuilding of municipal power plant, recently partially destroyed by fire. New equipment will be installed.

TWIN PORTS COOPERATIVE DAIRY ASSOCIATION, Superior, Wis., has plans for 1-story addition to power plant. Cost about $22,000.

STRAWBERRY POINT, Iowa, has low bid from Commonwealth Electric Co., St. Paul, Minn., at $26,670 for equipment for extensions in municipal electric power plant, including engine unit and accessories, and will make award at early date. Ralph W. Gearhart, 349 21st St., S.E., Cedar Rapids, Iowa, is consulting engineer.

MINERVA, OHIO, plans enlarging municipal power plant. Ralph Hadlow, Cleveland, Ohio, consulting engineer.

OHIO CITY, OHIO, will take bids soon for municipal power plant. Fund of $40,000 through Federal grant and loan. Carl J. Simon, Van Wert, Ohio, consulting engineer.

STATE BUILDING COMMISSION, Jefferson City, Mo., E. M. Eagan, executive secretary, will receive bids until Jan. 14 for extensions in power plant and electrical distribution system for state institution at Fulton. Baumes-McDevitt Co., Kansas City, Mo., consulting engineer, and Charles A. Haskins, Kansas City, general supervising engineer.

AUBURN, IND., has authorized surveys and estimates for a municipal power plant. Financing through Federal grant and loan.

CONSTANTINE, MICH., has plans maturing for new municipal power plant. Cost close to $100,000, with equipment. Frank F. Ven Tuyl, Ann Arbor, Mich., consulting engineer.

PANHANDLE EASTERN PIPE LINE CO., Kansas City, Mo., will carry out large expansion program in welded steel pipe line system in 1937, including new welded steel lines to increase supply of natural gas at Detroit, Mich. Will also build steel pipelines for natural-gas distribution in other parts of Michigan, as well as in Illinois, Missouri and Ohio. Work will include expansion in different compressor plants for increased booster service, as well as new booster stations. Total cost about $20,000,000.

UNITED STATES ENGINEERING OFFICE, Kansas City, Mo., contracted Enterprise Engine Corp., San Francisco, Calif., for 300-kw. diesel set, with accessory equipment, at $27,935.

SHELL PIPE LINE CORP., Shell Bldg., St. Louis, Mo., has completed surveys for new 10-in. welded steel pipeline from Hendricks oil field, Winkler County, Tex., to terminal plant at McCamey, Upton County. Booster pumps at points along route. Cost about $650,000.

FALLS CITY, NEB., contracted Fairbanks, Morse & Co., Chicago, Ill., for 1,400-hp. diesel set and auxiliaries at $78,822, for municipal power plant. Robert Fulton, Lincoln, Neb., consulting engineer.

CONTAINER CORP. OF AMERICA, INC., 111 West Washington St., Chicago, Ill., plans power plant at proposed new pulp and paperboard mill at Fernandina, Fla., where large tract of land has been secured. Entire project, costing about $5,000,000, will be carried out during 1937. George F. Hardy, 305 Broadway, New York, N. Y., is consulting engineer.

MENTOR, OHIO, plans municipal waterworks and system, including two centrifugal pumping units and accessories, two turbines, 10,000-gal. elevated steel tank and tower, meters and auxiliary equipment. $120,000 is being arranged through Federal aid. Paul Elwell, 5005 Euclid Ave., Cleveland, Ohio, consulting engineer.

DELPHOS, OHIO, plans municipal plant and distributing system. Cost close to $400,000. Financing through Federal aid. Carl Simon, Van Wert, Ohio, consulting engineer.

WEST MICHIGAN CONSUMERS CO. has started Lindewelding a 6-in., 12-mile gas pipeline from a new gas field near Ravenna, Mich., to Muskegon, Mich.

STATE BOARD OF CONTROL, State Capitol Bldg., Lincoln, Neb., O. R. Shatto, secretary, is arranging appropriations for new steam power plants for central heating service at number of institutions, including Girls' Industrial School, Geneva, Neb., to cost $30,000; Boys' Industrial School at Kearney, Neb., cost $40,000; Women's Industrial School, Milford, Neb., cost $30,000; State Hospital at Kearney, to cost $165,000, including new ward building. Pumping machinery and auxiliary equipment will be purchased for increased water supply at State Hospital at Norfolk, Neb., where over $250,000 will be expended.

BOARD OF EDUCATION, Waterloo, Iowa, is considering installation of fuel-handling equipment in power house in Western School District, including coal conveyor, ash hoist and accessories.

MANCHESTER, OHIO, is considering municipal power plant and will have plans soon. Fund of about $30,000 will be arranged through Federal aid.

ROCK RAPIDS, IOWA, contracted Westinghouse for turbo-generator, also Link-Belt Co. for coal and ash-handling equipment, J. F. Pritchard Co. for cooling tower and John V. Boland Co. for stack. New plant will cost about $200,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

WALHALLA, N. D., has plans for municipal plant. Cost about $50,000. Fund of $40,000 through Federal aid. C. D. Norton, Bismarck, N. D., consulting engineer.

HOMESTAKE MINING CO., Lead, S. D., has work in progress on new compressor plant, for which two 5,000-cu. ft. air compressors and accessory equipment have been furnished by Nordberg Mfg. Co., Milwaukee, Wis. Entire project will cost about $150,000.

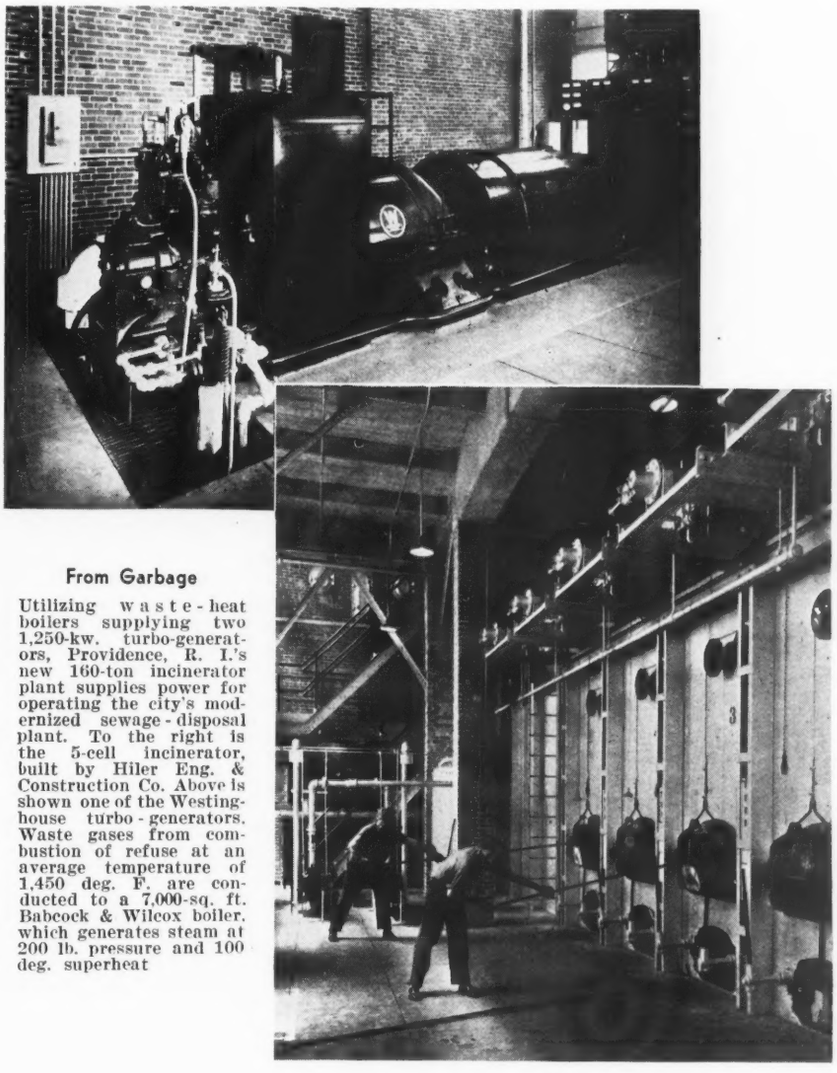
NELSONVILLE, OHIO, has secured $81,818 through Federal aid for extensions and improvements in municipal plant.

V. S. TOBACCO CO., 4325 Fifth Ave., Chicago, Ill., let general contract to Arnold L. Spietz, 127 North Dearborn St., for 1-story addition to steam power house, 36 x 40 ft. Cost close to $30,000. Schmidt, Garden & Erickson, 104 South Michigan Ave., architects.

FLANDREAU, S. D., has Federal financing of $168,770 for municipal plant.

GALION, OHIO, will take bids soon for extensions and improvements in municipal plant, including a 3,000-kw. turbo-generator.

ACKLEY, IOWA, is considering extensions and improvements in municipal plant, with installation of generator and accessory equipment.



From Garbage

Utilizing waste-heat boilers supplying two 1,250-kw. turbo-generators, Providence, R. I.'s new 160-ton incinerator plant supplies power for operating the city's modernized sewage-disposal plant. To the right is the 5-cell incinerator, built by Hiler Eng. & Construction Co. Above is shown one of the Westinghouse turbo-generators. Waste gases from combustion of refuse at an average temperature of 1,450 deg. F. are conducted to a 7,000-sq. ft. Babcock & Wilcox boiler, which generates steam at 200 lb. pressure and 100 deg. superheat

CAVEAT EMPTOR . . .

Latin phrases, which look so impressive on a family shield—and when they look most impressive often mean least—have always been a red flag to me. So many of them hide a false feeling or an abiding egotism. But *caveat emptor*—"Let the buyer beware"—is a symbol of something even less desirable.

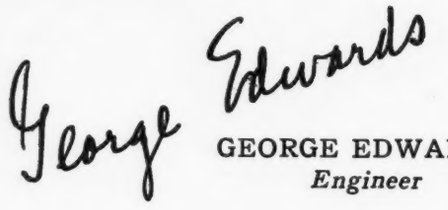
Always there have been craftsmen, men who held their integrity above material gain, but the usual attitude has been the opposite. Horse trades reflect more momentary glory upon their successful makers than fair dealing, so all countries and all peoples have had salesman's tricks. They end up by making the buyer realize only one thing—that what he buys from the trader isn't all it's cracked up to be. That in turn means eventual trouble for the company that has failed to curb the horse-trade technique.

There is no more reason for *caveat emptor* than for *caveat vendor*—"let the seller beware." There is no excuse for the smart deal, the sales trick, the hard-driven bargain—except that everybody else does it. And that is little enough of an excuse, if you remember also that the rest of your life you'll be staring back at the man whom you see every morning as you shave. After all is said and done, a man must live with himself, and the smart trick now may turn out to be a later uncomfortable bedfellow.

Furthermore, the full-value product requires no smart selling, no over-statement, no blatant argument—it will sell on its merits if buyers only can learn of it. To make them hear of it, value will work just as effectively and a lot more lastingly than a medicine show. Perhaps it is time for us to get back to straight statement and honest fact, time for us to get back on to a basis where a man's word is as good as his bond.

I have always hoped to be considered a square shooter—or at least an honest man. Yet when I think back on it, I'm surprised at the number of times I've been anything but that. Excuses are easy to concoct, and at the moment sometimes seem better than plain fact.

So this New Year's, no resolutions of the usual sort. Maybe just a good try at thinking what I say, and saying what I think, expecting the other fellow to do the same thing. If he fails I'll find out sooner or later. If I fail, well, it will be something else not so comfortable to remember when I realize that after all, a man must eventually live with himself—and you don't enjoy living with somebody you don't respect.



GEORGE EDWARDS,
Engineer

MEASURES JUST 2x2⅝x4½

YET IT'S ONE OF THE

NEW CUTLER-HAMMER FRACTIONAL HORSEPOWER DRUM CONTROLLERS

FOR SINGLE- AND MULTI-SPEED MOTORS

Once more, the Cutler-Hammer engineering staff sets the pace in control design—this time with a new line of drum controllers for fractional h.p. motors—and each controller is approximately *one-fourth the size of any present controller doing equivalent work.* Yet in these remarkable new units all the famous features of Cutler-Hammer Drum Controller design found in the huge C-H Drum Controllers used for the heaviest duties in industry (non-stubbing fingers, renewable contacts, insulated cylinder, etc.) are retained.

New design, new construction make this startling reduction of size possible—and greatly extend the field of application. These drum controllers fit any fractional h.p. motor, whether for home, workshop, household utilities, or for mill, shop and factory. See these controllers at once, so that you can start thinking in terms of their new usefulness. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* 1310 St. Paul Ave., Milwaukee, Wisconsin.

CUTLER-HAMMER
MOTOR CONTROL
C-H

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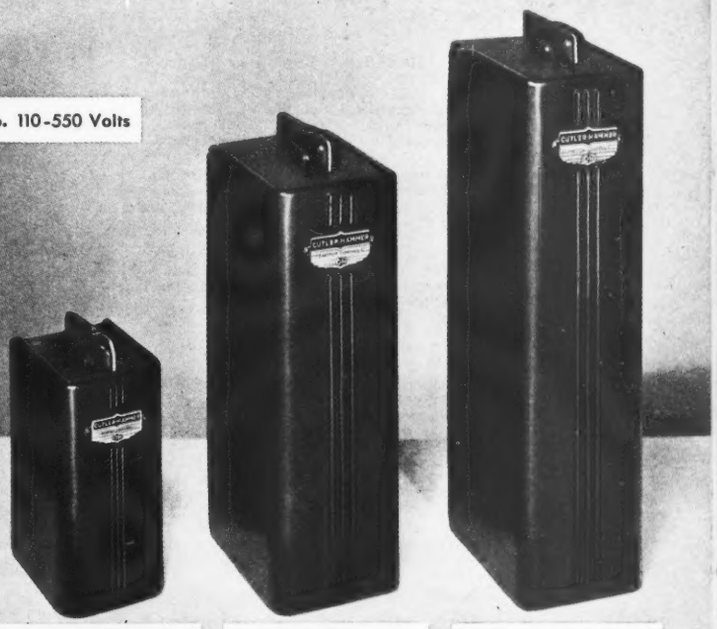


Bulletin 9441—Single Speed Reversing Drum Controller

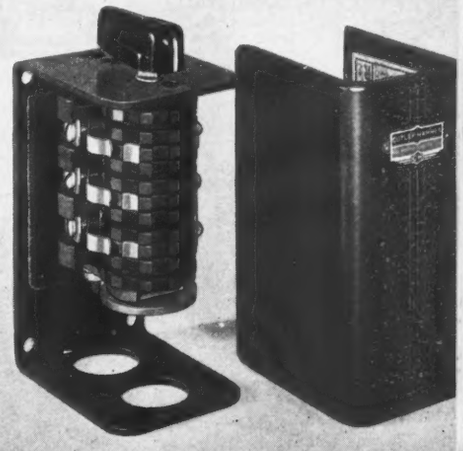
Bulletin 9402—2-Speed Drum Controller

Bulletin 9402—4-Speed Drum Controller

"AIR STYLED" For Modern Machines

Bulletin 9441—Single Speed Reversing Controller shown at right

Note easy access for wiring. Terminals out in front. Rugged construction. Contacts easily replaced. Available for flush mounting. All types arranged for conduit wiring. List price $4.00. Other sizes in proportion.



NEWS BULLETINS

Thermometers—Instrument Service Co., Inc., 310 Twelfth St., Hoboken, N. J. 8-page bulletin T-150, "Industrial Type Accuro-thermeters." Gives prices, sizes, types.

Boiler Water Conditioning and Combustion Control—Hagan Corporation, Pittsburgh, Pa. New bi-monthly house organ, "Dual Service News," describes Hagan-Hall installations and services. First issue August, 1936.

Centrifugal Pumps—Worthington Pump and Machinery Corp., Harrison, N. J. 8 pages. Bulletin W-313-B-1 "Mixflo Pumps," describes uses, types and sizes. Photographs, sectional drawings and dimension tables included.

Seamless Connectors for Wire and Cables—Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y. Bulletin C-8 containing equipment and tools for making splices in circuits from No. 12 B&S gage wire to 350,000 C.M. cable.

Pipe Fittings—Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill. Net price list No. 70-1 covers complete line of "Uniclamp" pipe fittings.

Forging Presses—Chambersburg Engrg. Co., Chambersburg, Pa. 11-page bulletin No. 300, "High Speed Steam-Hydraulic Forging Presses," covering description and method of operation. Illustrated with dimension tables and sectional drawings.

Heating Systems—Webster Tallmadge & Co., Inc., East Orange, N. J. 1-page folder "Tallmadge Zoned Heating Systems."

Turbine Pumps—Roots-Connersville Blower Corp., Connersville, Ind. "Regenerative Turbine Pumps," a 4-page bulletin 260-B11B, describes structural features and range of applications. Table of capacities and heads and performance chart.

Oil Heaters—The Griscom-Russell Co., 285 Madison Ave., New York, N. Y. 4-page bulletin, "The G-R Storage Tank Oil Heater," shows new flanged fin-type pipe for heating oil with exhaust or high-pressure steam.

Materials Handling Machinery—Gifford-Wood Co., Hudson, N. Y. 111-page, bound catalog No. 136. Describes and lists complete line of handling equipment, including elevators, conveyors, feeders, hoists, screens and hoppers for all uses. Well illustrated.

Motors—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Leaflet 20652 describes Type SK d.c. motor designed to withstand internal explosion caused by coal dust or gas.

Speed-Control Systems—Reeves Pulley Co., Columbus, Ind. 32-page booklet showing recent uses and installations of Reeves speed-control equipment, and line of sizes, models and designs.

Condenser Tubes—Bridgeport Brass Co., Bridgeport, Conn. New house organ covering condenser tube use and problems. No regular publication date.

High-Temperature Steels—The Timken Steel & Tube Co., Canton, Ohio. 8-page bulletin announcing new series of silicon-chromium - molybdenum, high - temperature, oxidation- and corrosion-resistant steels.

Meters—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 15-page catalog section 42-210 showing Westinghouse polyphase detachable meters. Applications, construction, operation, outline dimensions and wiring diagrams.

Draft Dampers—Preferred Utilities Mfg. Corp., 33 W. 60th St., New York, N. Y. 4-page folder describing "Preferred Draft-A-Justors," commercial and domestic sizes.

Pumps—Hoffman Specialty Co., Inc., Waterbury, Conn. Vacuum and condensation pumps shown in folder bulletin. Types and purposes described; also heavy-duty steam traps to accompany pumps.

Temperature-Control Equipment—The Brown Instrument Co., Philadelphia, Pa. Broadside describes electric and air-operated control thermometers; entirely automatic. Also presents descriptions of "Con-Tac-Tor" sealed mercury switches.

Heaters—National Fan & Blower Corp., Chicago, Ill. 8-page bulletin No. 16. Shows propeller and blower-type heating units for commercial and industrial use. Capacity tables and dimension charts.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ala., Prichard—S. H. Cochhran, Prichard, plans electric power plant and distribution lines. $100,000. Franchise granted.

Calif., El Centro—Imperial Irrigation Dist., bids about Jan. 19, constructing new hydro-electric plant, enlargement of present Diesel electric plant at Brawley and constructing transmission lines. $2,700,000. Financing with aid of federal funds. M. J. Dowd, El Centro, engr.

Colo., Lake City—Townsend Lead-Zinc Co. plans constructing power plant on Lake Fork, incl. 70 ft. dam and 3,000 ft. conduit at Lake San Cristobal.

Fla., Jacksonville—Federal Government approved $1,127,000 grant for improvements and extensions on Jacksonville municipal electric plant. An additional amount of $1,150,000 will be supplied from the earnings of the plant. Improvements consist of new intake tunnel and new steam turbine at main plant and other machinery for various sub-stations, also considerable extensions in power distribution lines to enlarge rural electrification service.

Ind., Bremen—Municipality plans by LeRoy Bradley, Fort Wayne, electric light and power plant. To exceed $37,000.

Ind., Logansport—State Hospital, C. L. Williams, supt., soon takes bids power house and central heating plant at State Hospital. $134,700. P.W.A. grant of $60,615 approved. Bevington-Williams, Inc., 1139 Indiana Pythian Bldg., Indianapolis, consult. engrs.

Ind., Newcastle—Public Service Co. of Indiana, plans improving plant, incl. installing 3 new transformers at central sub station, additional transformers and other equipment, at Chrysler plant and additional equipment at Ingersoll Tool and Disc Plant. $250,000. P. McLeod, division mgr.

Ia., Bettendorf—Moline-Rock Island Mfg. Co., improving plant with 25,000 kva unit at Iowana Riverside Power Station, contract to United Light & Power Co., designer and contractor, 205 Perry St., Davenport. $1,500,000.

Ia., Forest City—Municipality Forest City plans by Young & Stanley, Muscatine, constructing electrical power and light plant. $165,000.

Ia., Storm Lake—City petition filed with Town Bd. for municipal light plant. An electrical engineer will be employed for survey and committee in charge will request a special election be held to vote on project.

Kan., Kansas City—D. T. McCombs, mayor, City Hall, bids late in December or early in January, 2 story, 150x200 ft. addition to power plant, $375,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Ky., Greenbrier—Nelson County Distillery, Inc., Bradstown, J. E. Conway and C. E. Keith, in charge, constructing power house, stills and warehouses for distillery, day labor and separate contracts, under supervision of owner. Est. $150,000.

Mich., Dowagiac—City, plans additions and improvements to municipal power plant. $200,000. Ayres, Lewis, Norris & May, Ann Arbor, engrs.

Minn., Halsted—Village, A. Opgrand, clk., plans power plant building, equipment, distribution system. About $75,000. Will apply for W.P.A. funds. E. G. Briggs, 1955 University Ave., St. Paul, engr.

Minn., Northfield—Municipality plans by Municipal Construction & Finance Co., Lincoln, constructing electric light and power plant. $25,000.

Mont., Flathead—Montana Power Co., Butte, constructing Flathead hydro-electric project on Flathead River, incl. 200 ft. high concrete arch dam, penstock tunnels, power house and two 56,000 k.w. hydro-electric units. Contract to Phoenix Eng. Corp., 2 Rector St., New York City.

Mo., Cabool—Municipality plans diesel electric power plant. $50,000.

Mo., Holly Springs—Municipality plans constructing electric power plant and 60 mi. distribution lines. $70,000.

Neb., Arnold—City plans constructing municipal light plant. Petition filed with City Bd. and will apply to P.W.A. for loan if board takes favorable action.

N. J., Camden—Radio Corporation of America, Front and Cooper Sts., constructing steam power plant and factory improvements, separate contracts. To exceed $37,000.

N. Y., Dresden—New York Central Electric Corp., c/o Associated Gas & Electric Co., 61 Bway., New York, plans electric light and power plant, on Lake Seneca, $3,435,000, also transmission lines, $1,332,000.

N. Y., Elmira—Elmira Light, Heat & Power Corp., Elmira, plans constructing 15,000 kw. power plant addition. Est. about $1,000,000.

N. Y., Perrysburg—Dpt. Health, G. J. Zimmerman, mayor, City Hall, plans constructing additions to J. N. Adams Memorial Hospital, incl. school for child patients, chapel, employees building, power house and laboratory. $643,000. Architect and engineer not appointed.

N. Y., Rochester—Eastman Kodak Co., Kodak Park, plans constructing boiler house, Kodak Park. To exceed $37,000. Private plans.

N. Y., Silver Creek—Bd. Village Trustees, preliminary plans completed constructing municipal light and power plant, incl. changing equipment throughout village from 25 to 40 cycle. $206,000. Special election soon to vote on bond issue. P. P. Loftus, Oliver Bldg., Pittsburgh, Pa., engr.

N. Y., Tonawanda—DuPont Cellophane Co., River Rd., plans constructing boiler house and warehouses at rayon and cellophane plant, River St. $38,000. Private plans.

N. C., High Point—City, E. M. Knox, mgr., P.W.A. has approved grant of $2,595,000 to construct hydro-electric plant on Yadkin River, 12 mi. from Winston-Salem, consisting earth dam having maximum height 84 ft. provided with 500 ft. spillway having capacity of 157,000 cu. ft. per second, reservoir will cover 15,000 acres in Yadkin Co. Est. $6,000,000. W. C. Waldo, Wash., D. C., engr.

N. C., Kinston—Town election Jan. 7 to vote bonds for improvements to municipal power house, new boiler, etc. $125,000. D. Wooten, Kinston, mayor.

O., Columbus—City plans construction, equipment and housing of new boiler and other improvements, incl. coal conveyor and track for coal storage, etc. for municipal light plant. $260,000. R. Tucher, Columbus, supt. Municipal Light Plant. Llewelyn Lewis, service dir., in charge.

O., Napoleon—Municipality plans improvements to electric light and power plant. To exceed $37,000. Froelich & Emery, 2nd Natl. Bank Bldg., Toledo, engrs.

O., South Charleston—Municipality plans electric light and power plant. $80,000. H. Collins Wight, Union Trust Bldg., Dayton, engr.

O., Springfield—Ohio Edison Co., H. E. Miller, mgr., making plans addition to present steam generating plant on Mad River, near here, to increase capacity 20,000 kw. per hr. $1,500,000 plus. **Maturity in 1937.**

O., Union City—Municipality plans electric light and power plant. $130,000. Hoover & Montgomery, Atlas Bldg., Columbus, engrs.

Okla., McAlester—Bd. Affairs, Capitol Bldg., Oklahoma City, made preliminary plans constructing power house at State Penitentiary. $50,000. J. C. Milliken, Capitol, engr.

Okla., Ponca City—City plans improving power plant, incl. one 2,250 hp. diesel generator and switchboard. $175,000. Burns & McDonnell Eng. Co., 107 Linwood Blvd., Kansas City, Mo., engrs.

Tenn., Knoxville—University of Tennessee plans by F. L. Wilkinson, Jr., 209 Lake St., electric power plant. $55,000.

Tex., Brenham—City plans light and power plant, incl. three 750 h.p. engines, electrical distribution system, etc. $310,000. Garrett Eng. Co., Box 1726, Houston, engrs. P.W.A. allotted $140,000 funds.

Wash., Plaza—Spokane County Rural Electric Cooperative plans constructing 205 mi. line and 900 kilowatt diesel generating plant to serve 600 customers to Spokane and Whitman Counties. $290,000 allotted by R.E.A.

Va., Suffolk—Municipality plans electric light and power plant, $31,000.

N. S., Halifax—Nova Scotia Power Comn., making plans hydro-development at Centre East Pubnico. $75,000. Private plans.

N. S., Picton—Picton County Power Bd. making plans constructing steam generating plant. $250,000. G. R. Saunders, Picton, engr.

Ont., Goderich—Municipality plans constructing municipal electrical development plant. $100,000.

Que., Magog—Municipality and Syndicate soon take bids power development near Magog at juncture of Salmon River and Brompton Lake, which will develop 4,000 h.p. $400,000. Crepeau & Cate, 32 Wellington St, W. Sherbrooke, consult. engrs. Z. Langlais, 105 Mountain Hill, Quebec City, engr.

Que., Noranda—Noranda Power Co., Ltd., Royal Bank Bld., Toronto, plans prepared power project to provide Abitibi region with electric energy, construction of dam, power plant, etc. $5,000,000. F. A. Gaby, 660 St. Catherine St. W., Montreal, engr.